

## Sediment Characterization and Beachfill Borrow Area Assessment of the Delaware Bay Study

Report 1
Identification of Sediment Types Offshore of the Broadkill Beach, Delaware, Area

by Donald K. Stauble, Richard G. McGee

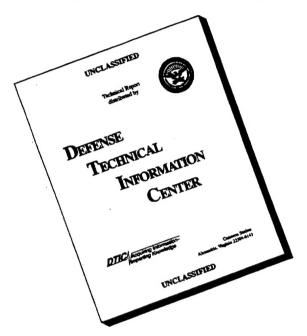


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## Sediment Characterization and Beachfill Borrow Area Assessment of the Delaware Bay Study

Report 1 Identification of Sediment Types Offshore of Broadkill Beach, Delaware, Area

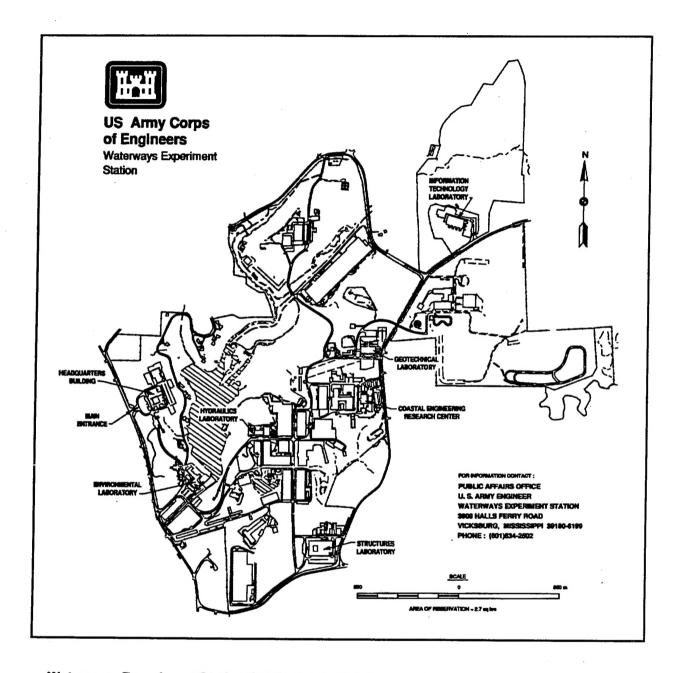
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Vicksburg, MS 39180-6199

Report 1 of a series

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### **Preface**

The work described herein was authorized as part of a Feasibility Report for the Delaware Bay Study, U.S. Army Engineer District, Philadelphia (NAP). The study was conducted by the U.S. Army Engineer Waterways Experiment Station's (WES's) Coastal Engineering Research Center (CERC) and Hydraulics Laboratory (HL). Technical Monitors at Headquarters, U.S. Army Corps of Engineers, were Messrs. John H. Lockhart, Jr., and Barry W. Holliday.

This report was prepared by Dr. Donald K. Stauble, Team Leader, Coastal Geology Unit, Coastal Structures and Evaluation Branch (CSEB), Engineering Development Division (EDD), CERC, and Mr Richard G. McGee, HL. Dr. Stauble was under the administrative supervision of Ms. Joan Pope, Chief, CSEB, Mr. Thomas Richardson, Chief, EDD, Mr Charles C. Calhoun, Jr., Assistant Director, and Dr. James R. Houston, Director, CERC. Mr. McGee was under the administrative supervision of Dr. Bobby J. Brown, Chief, Hydraulics Analysis Branch, Mr. Richard A. Sager, Assistant Director and then Acting Director, and Mr. Frank Hermann, Director, HL.

Work on this project was a cooperative effort between personnel of CERC, HL, and the WES Geotechnical Laboratory (GL). Seismic field data collection was done aboard the R/V Waterways Explorer (WES). Data collection was assisted by Messrs. Rodney Leist and Thomas S. Harmon, GL, Mr. Sam Varnell, HL, and Mr. David Caulfield, President, Caulfield Engineering Group, Oyama, British Columbia, Canada. Assistance in data reduction was provided by Ms. Claire Livingston (CERC, HL, and GL), and Ms. Darla McVan, HL. Mr. Brian Williams, HL, provided graphics support. Mr. Brian Murtaugh, Geotechnical Branch, NAP, provided the core logs and gradation curve data and acted as project monitor.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

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## Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	Ву	To Obtain
feet	0.3048	meters
inches	2.54	centimeters
miles (U.S. nautical)	1.852	kilometers
pounds (mass) per cubic foot	16.01846	kilograms per cubic meter

### 1 Introduction

In response to a request from the Philadelphia District (NAP) for assistance in identification of beachfill borrow areas offshore of the Delaware and New Jersey coasts within the Delaware Bay as part of a Feasibility Report for the Delaware Bay Study, the Coastal Engineering Research Center (CERC) in conjunction with the Hydraulics Laboratory (HL) at the U.S. Army Engineer Waterways Experiment Station (WES) is submitting Report 1 on the identification of sediment types offshore of the Broadkill Beach, DE, area.

Eroding areas of the bay shoreline have resulted in a need to investigate the shallow offshore areas of the bay adjacent to both the Delaware and New Jersey coasts for use as a borrow area for beachfill material. The area is relatively unexplored from a geotechnical standpoint and this investigation will provide acoustical subbottom profiling, vibracore locations, and interpretation of the sediment substrate of the study area. Figure 1 shows the extent of the seismic track lines and location of the sediment cores for the entire study area. The study will be subdivided into several reports on sections of the coast. Field work was conducted to provide seismic tracks of the study area. Existing data were reviewed concurrently to incorporate these data into the study. Vibracore locations were chosen based on the seismic data collected for this study and the existing data. The vibracore collection was done by the District, and provided to WES. Seismic and sedimentological data from these cores were interpreted, and this report characterizes the sediment of the Broadkill Beach portion of the Delaware Bay study and suggests suitable borrow areas for beachfill use.

Modern sedimentary deposits in Delaware Bay are controlled by past geologic processes. Lower Delaware Bay was thought to be a dendritic drainage pattern of gravely and muddy sands during the late Wisconsinan low stand of the sea around 15,000 to 12,000 years ago (Knebel et al. 1988). As sea level rose, the estuary became flooded as the bayside shoreline retreated northwest along the pre-transgression topography. A detailed history of the evolution of the bay shoreline on the Delaware side of the bay is presented in Fletcher et al. (1990). The sediment and bathymetry off Broadkill Beach are a result of this transgression of sea level into the drowned river valley. Coarse-grained sediments were originally deposited in the river beds. Rising

Chapter 1 Introduction 1

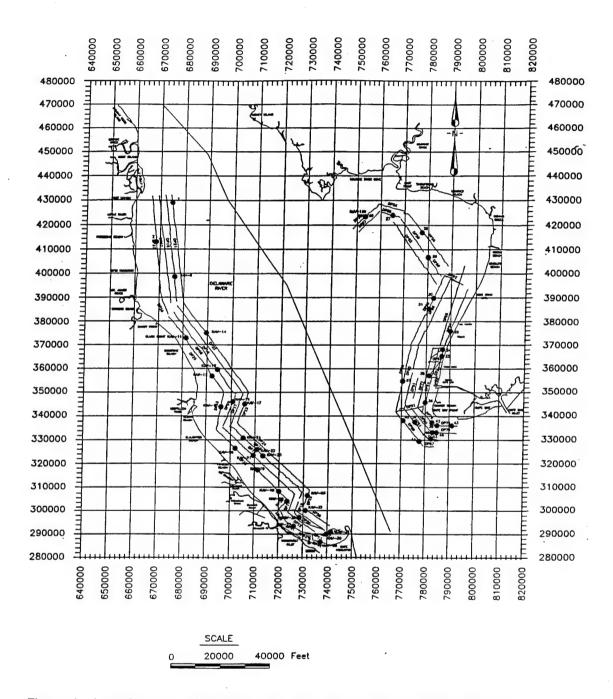


Figure 1. Location map of seismic track lines and cores collected along the Delaware and New Jersey shore of Delaware Bay<sup>1</sup>

A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page vi.

sea level flooded these river valleys and fine silts and clays were deposited as the turbidity maximum migrated up the estuary. As the estuary grew, narrow barrier and headland beaches composed of fine to coarse sands were formed from wave and tidal action. Tidal marshes composed of silts were formed behind these barrier islands in the tributary river beds. In the present-day open estuary, sediment scour, reworking, and transport have become the dominant processes. Delaware Bay is a well-mixed estuary from Port Mahon to the bay mouth at Cape Henlopen.

Chapter 1 Introduction

### 2 Approach

Field work included planning, testing, and collection of new acoustic subbottom profile data along the Delaware and New Jersey shore adjacent areas (5-20 ft depths). The area between Port Mahon and Lewes, DE, was studied from approximately 1 to 3 miles offshore. The area approximately 1 to 3 miles offshore between the Maurice River mouth and Cape May Point was studied on the New Jersey side of the Bay. This field work was conducted on both the Delaware and New Jersey sides of the Delaware Bay in conjunction with field work on the Delaware River Main Channel Preconstruction and Engineering Design Study during the summer of 1993. The R.V. Waterways Explorer was outfitted with a fathometer, side scan sonar, 3.5-kHZ subbottom profiles, and a 600- to 900-Hz bubble pulser. A differential global positioning system (DGPS) was used to provide accurate positioning of the seismic lines. Details of the acoustic calibration are presented in the Delaware Ship Channel report by McGee (in preparation).

An analysis of core locations was provided to NAP at the completion of the field work to allow for a contract for vibracoring to the done 1994. Sediment core logs and sediment grain-size analysis was performed by the South Atlantic Division Laboratory in February 1995. Analysis of the sediment characteristics and borrow area identification was done after receipt of the vibracore data from NAP in April 1995. The data analysis has been divided into two separate subsections that separates the analysis of the Delaware and New Jersey sides of the Bay at the request of the District. Similar analysis is being performed on both data sets and the data has been presented to the District in GIS-compatible format.

A review of existing sets of subbottom and core data was combined with the new field data collected to assess the bathymetry, stratigraphic sequences and sediment composition of the upper 20 ft of sediment along the Delaware and New Jersey shore adjacent areas of Delaware Bay. This report will focus on the southern Delaware Bay shore area between the coast and 3 miles offshore, from an area just south of the Mispillion River to Cape Henlopen. This includes the area offshore of Lewes and Broadkill Beach.

After the field work was completed a review the seismic data and assessment of the best locations to take cores to identify the sediment

characteristics and ground truth the seismic signature. Details of the analysis procedure are located in McGee et al. (1995).

## 3 Analysis

## Identification of Possible Beach Fill Borrow Areas and Sand Substrate Identification

The purpose is to assist NAP with techniques and evaluation of the suitability of borrow areas for possible beach fill projects adjacent to the Delaware and New Jersey bay shoreline. Sediment data typing, grain size analysis interpretation and suggestion of borrow areas is provided to assist the State of Delaware in a proposed beach fill project along Broadkill Beach. Broadkill Beach is a small community located on the bay shoreline, 5 miles north of the mouth. A map has been generated and originally sent to the district by INTERNET as requested that shows the possible bottom types that can be used to select areas for possible sand sources for beach nourishment (Figure 2). This map of the surface sediment types was constructed from analysis of the seismic data and the surface sediment data from the cores. The use of core information has allowed a better refinement of the seismic data. The map outlines the best areas for possible sand.

Additional information, taken as part of a State of Delaware study of the nearshore area off Broadkill Beach, DE. was supplied by the State of Delaware. Two technical reports by Wethe et al. (1982) and Wethe (1984) indicate that there may be possible sand in the nearshore vicinity of Broadkill Beach. This area was inshore of our seismic study. A copy of the pertinent core locations and possible sand sources from these reports are found in Figure 3. Several former borrow areas used in 1961, 1973, 1975, 1976, and 1981 are shown in the nearshore region (around 1,000 ft from shore).

Former pre-transgressive river valleys appear to trend offshore in a southeast direction from the three present day rivers in the area (Maley 1981). Sand size material was identified in shoals between these former valleys (Figure 4). Cross-sections from Maley (1981) in the inshore area indicate that the sand shoals are over lagoonal mud deposits, particularly in the ancient valleys (Figure 5). The present data agrees with the Delaware reports. The interpretation of the surface acoustic impedance and sediment data shows that sand areas appear to trend in a NW-SE direction from the Delaware shoreline



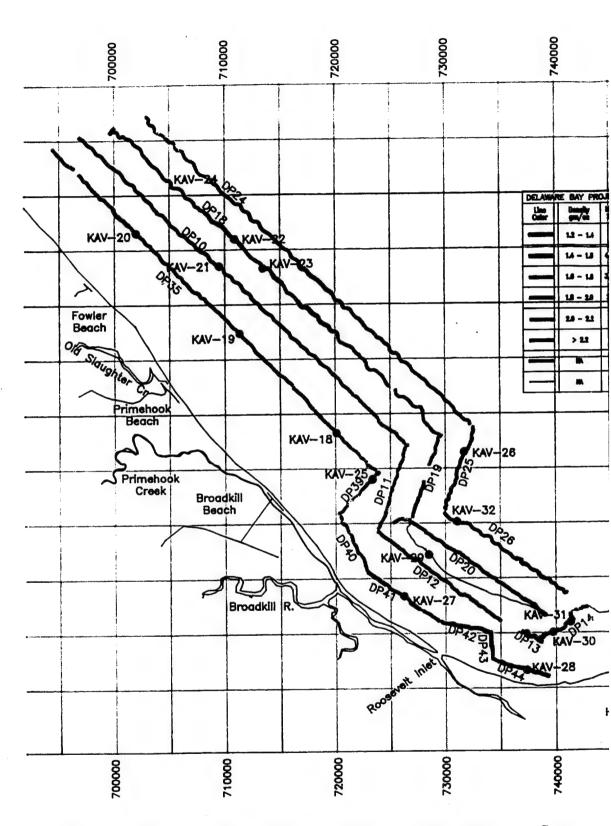
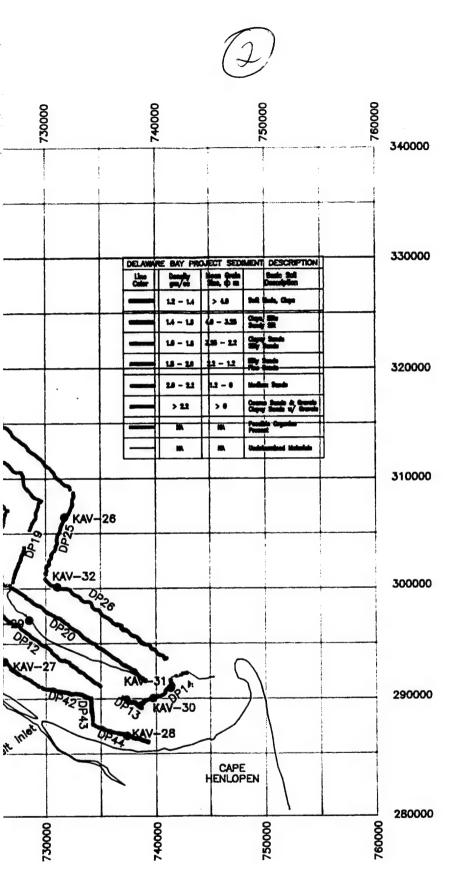


Figure 2. Detail of seismic lines and core locations from Mispillion River to Cape Henlopen, DE. showing surface sand types



m Mispillion River to Cape

ediment Types

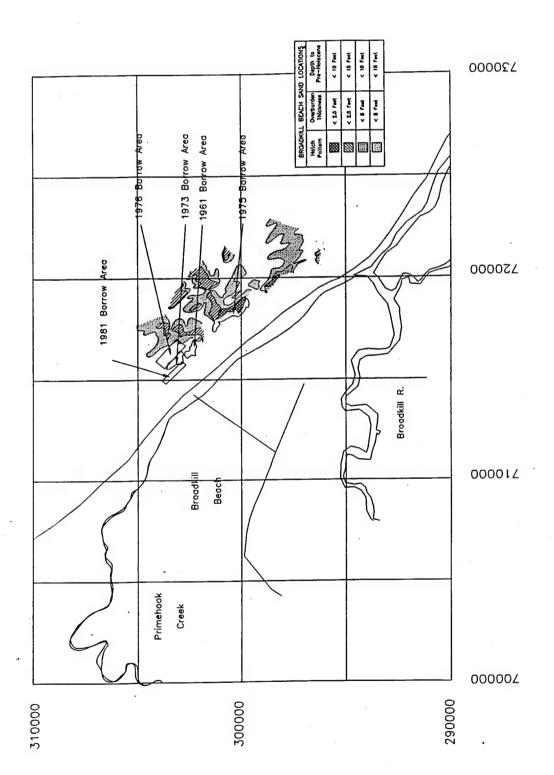
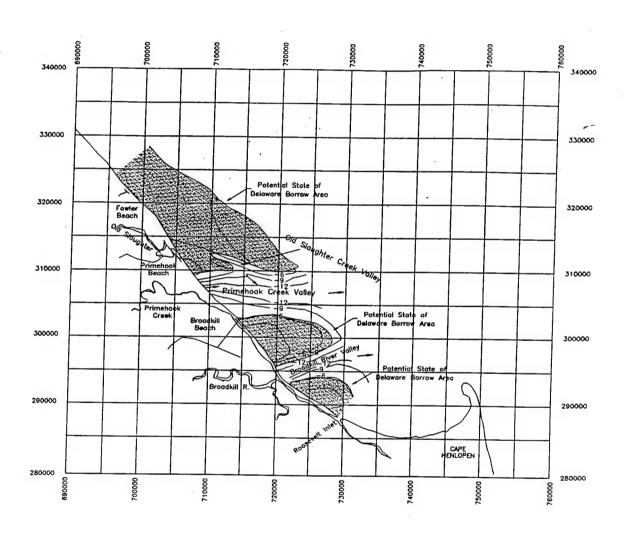


Figure 3. Location of inshore sand deposits and borrow areas (after Wethe (1982))



LEGEND

Ancient River Channels
Topography to -12 Meters
---- Present Day Conturs
---- Ancient River Valley Contours

Figure 4. Location of sand shoals and ancient river valleys around Broadkill Beach (after Maley (1981))

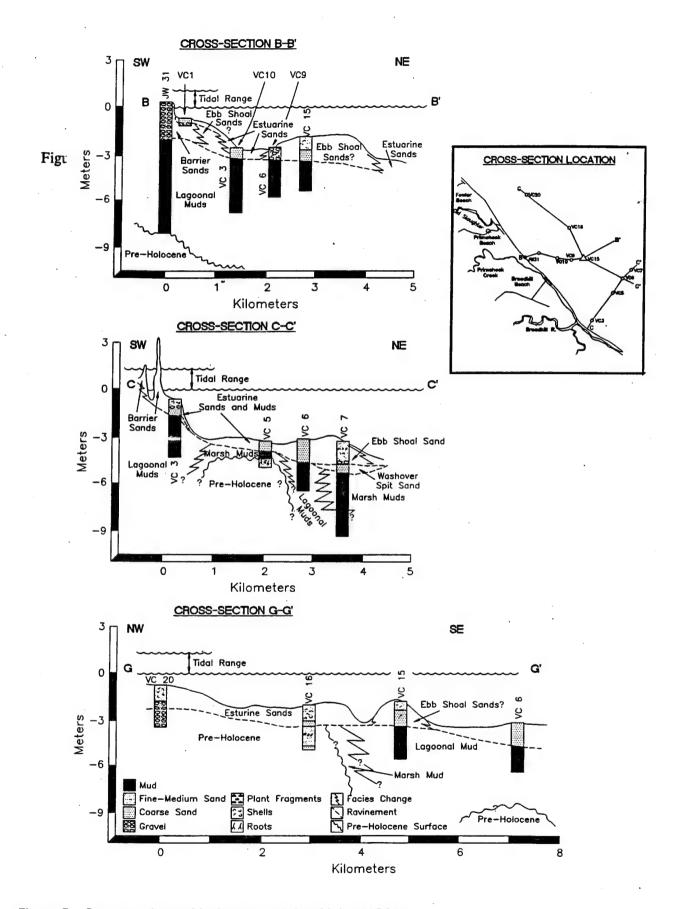


Figure 5. Cross sections of inshore area (after Maley (1981))

off Broadkill Beach. The red, yellow, and green areas on Figure 2 identify the sand areas, with magenta, blue and brown areas denoting a mix of mostly silt and mud. The area behind Cape Henlopen is a basin that contains very fine grain surficial sediments. Some of the cores in Breakwater Harbor show a coarser Pleistocene sand deposit around 10 feet below the surface in this area, but for the most part the surface material is too fine for beach nourishment.

#### Line DP35

Acoustic impedance analysis of four seismic track lines off Broadkill Beach show the stratigraphic distribution of sediment with depth. Line DP35 was the closest to shore. Figure 6 shows the typical pinger data collected on that line. From this data and additional information of three cores taken along this line at KAV-18, KAV-19 and KAV-20, Figure 7 show the sequence of shoals and river valleys. The southern part of the line contains medium to fine surficial sands. The sediments grade into silts at a depth of around 12-14 ft. This area corresponds to the ancestral Broadkill River Valley as described by Maley (1981).

Core KAV-18 is located in the area of the southern tip of the shoal identified by Maley (1981). The surface layer contains a poorly sorted fine gravel down to 3 ft. Below that the majority of the sediments are poorly sorted sands with some gravel to a depth of 13 ft. Below that depth the sediments are a fine silt. Appendix A gives the core log and sediment gradation curves for each vibracore location.

The central part of seismic line DP35 has a section of fine silty sands at the surface, located in a valley between two shoals. This is the landward extent of a wedge of fine material. Core KAV-19 located in this valley indicates that this silty sand material extends to a depth of at least 17.5 ft and supports the acoustic signature of fines at depth. Below a 3 ft thick poorly sorted medium sand layer, there are well sorted fine sands that have silt contents between 10 and 35 percent.

The northern portion of the line contains medium to fine sandy surfacial sands. The northern part of this area is in another valley and the sediments grade into fine silts, possibly representing another ancestral river valley trending to the southeast. These fines may be outwash from an ancient more straight path of Slaughter Creek. Core KAV-20 in this northern area contains a thin gravely sand on the surface, with gravely clay lenses alternating with silts at depth. Most of the sediment has a  $D_{50}$  of around 0.05 mm (4.25  $\phi$ ) from 1 ft down to 8 ft and gets only slightly coarser below that depth. Below 3 ft, the sediment has iron staining.

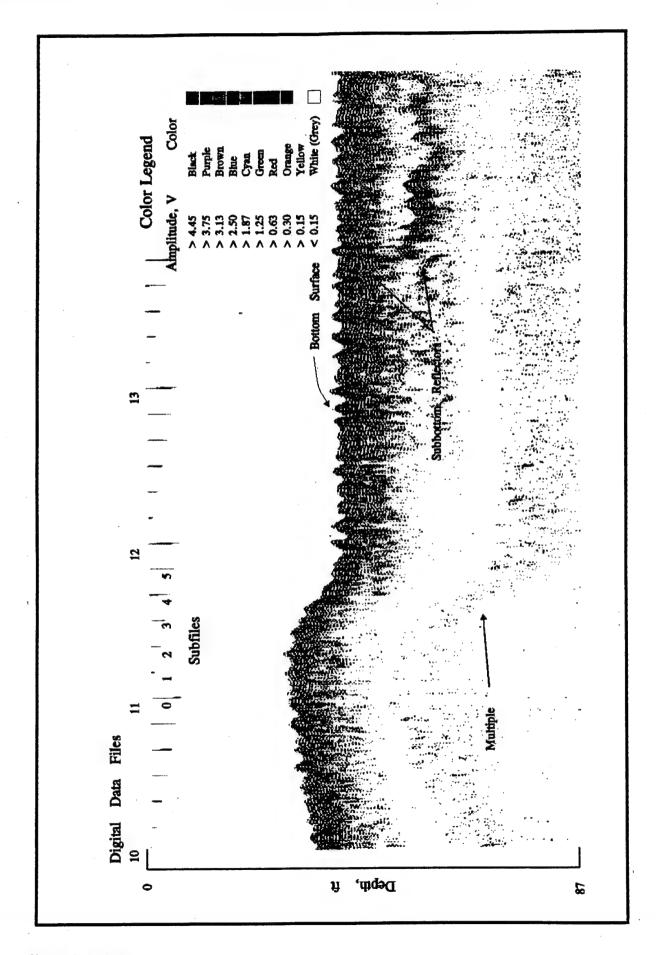
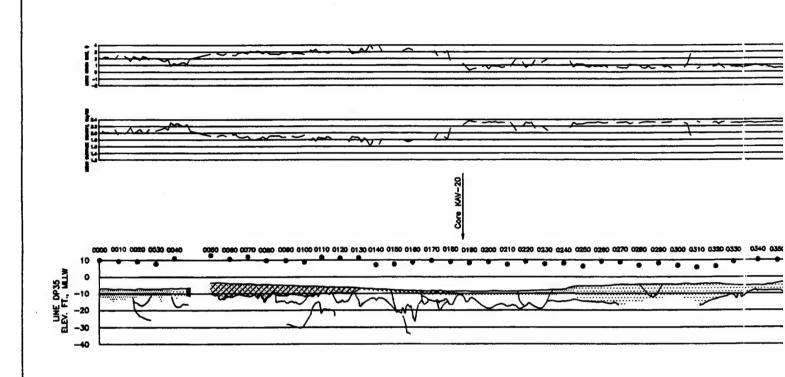


Figure 6. Example of typical pinger data record



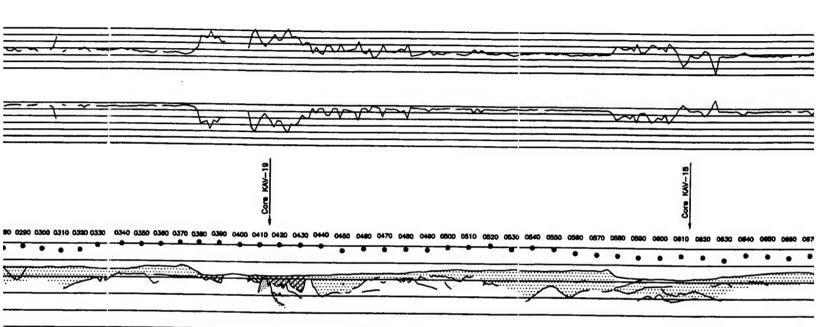


DELAWARE BAY PROJEC					
Hatch Pattern	Density gm/rc	Mea Size			
	1.0 - i.4	,			
	1.4 - 1.8	4 -			
	1.6 - 1.8	32			
	1,80	2.2			
***********	20 - 12	1.2			
	> 2.2	,			
	> 2.4	N			
		_			

Figure 7. Cross-section of Line DP35 with core locations

V.E.





DELAWARE BAY PROJECT SEDIMENT DESCRIPTION					
Hatch Pattern	Density gm/cc	Mean Grain Size, ¢ m	Bosic Soil Description		
	1.0 - i.4	>4	Soft Muds, Claye		
	1.4 - 1.6	4 - 3.2	Clays, Silts Sandy Silt		
	1.6 - 1.8	32 - 22	Clayey Sands Silty Sands		
	1.80	22 - 12	Silty Sands Fine Sands		
***********	20 - 12	1.2 - 0	Medium Sande		
	> 2.2	> 0	Coarse Sande & Gravele Clayey Sande w/ Gravele		
	> 24	N/A	Rock, Cosolidated Clays		

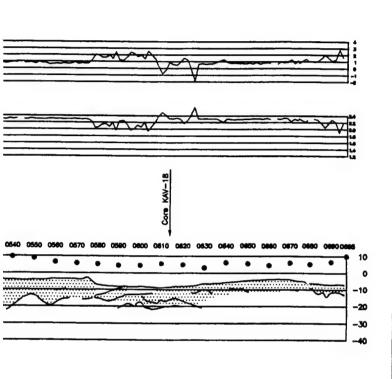
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WATERWAYS EXPERIME CORPS OF ENGIN VICKSBURG, MS

DELAWARE BAY PE SEDIMENT PRO LINE DP35

FILE NAME: DP35.DWG SCALE: 1"=1000" DATE: DECEMBER 11, 190

(3)



WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180

DELAWARE BAY PROJECT SEDIMENT PROFILE LINE DP35

FILE NAME: DP35.DWO

SCALE: 1"=1000" DATE: DECEMBER 11, 1985 SHEET

#### Line DP10

The second seismic line seaward of the shoreline was Line DP 10 (Figure 8). The northern, central, and southern sections of this line have medium to fine sand surficial sediments located on shoals. Between the shoals, finer silty sediments were found in the valleys. Core KAV-21 was located on the central shoal area and contains well sorted medium to fine sands representing the shoal on the surface and to a depth of around 7 ft. Below that depth most of the sediment is composed of silty sand with some clay lenses around 9 ft. This sediment at depth is finer bay material underlying the shoal.

#### Line DP18

Further bayward Line DP18 (Figure 9) contains sand size material on the southern end shoal feature. Cores located along this line included KAV-22, KAV-23, and KAV 24. The central section of the line contains fine sands and silts. Core KAV-23 is the southern most core on this line and is located in a pocket of fine sand. This core is composed of mostly silty sand, with lenses of silt between 2 to 7.5 ft and below 7.5 ft a gravel component. Core KAV-22, located on the middle of the line contains silty sand with some clay material in the surface layers. Sandy silt is also present within the upper 4 ft. From 4-8 ft, a well-sorted sand with from 10 to 20 percent silts was present.

Core KAV-24 is the northern most core and is located on the flank of a shoal which occupies the northern section of the line. The upper 5 ft of the core contains silty sand grading into well sorted medium to fine sands with between 2 and 10 percent silts. Between 5 and 14 ft, silt material is present with some sand-size material. Below 14 ft the gravel and sand content increases along with a silt layer.

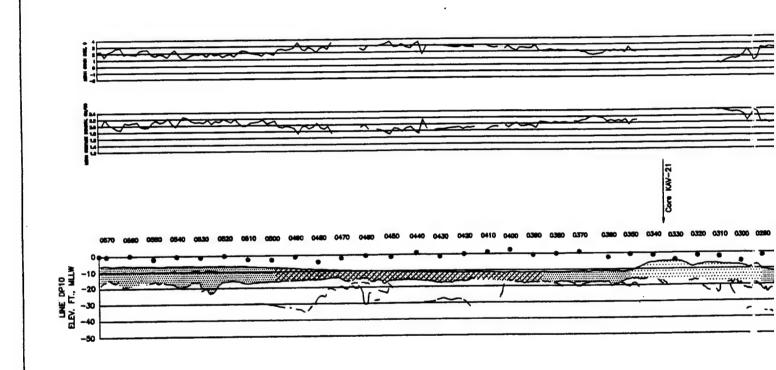
#### Line DP24

The most bayward seismic line is Line DP24 (Figure 10). No cores were collected along this line. The acoustic impedance analysis indicated that the southern end of the line has a sandy shoal feature. The central section is a long valley, containing finer sediments. A shoal of sandy material is at the northern end of the line. This central valley may be related to an ancestral river valley, possibly associated with Slaughter Creek, north of the study area. A deeply incised channel is present on the seismic record cutting down to around 45 ft below the bay bed.

#### Line DP39

Line DP39 is almost shore normal, extending bayward from just south of Broadkill Beach. Figure 11 shows the cross-section of Line DP39 with core KAV-25 at the northeast end. The entire line is composed of medium sized sand.

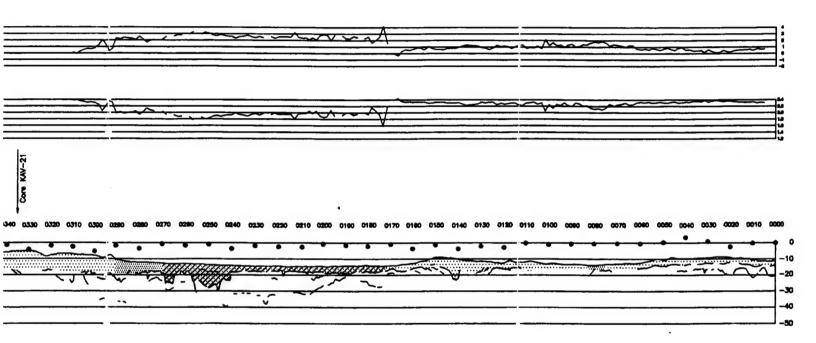




DELAWARE BAY PROJECT S					
Hatch Pattern	Deneity gm/cc	Muon G Size, ф			
	1.0 - 1.4	> 4			
	1,4 - 1.8	- 33			
	1.6 - 1.8	32 - 2			
**********	1.8 - 2.0	22 - 1			
*********	20 - 22	2 -			
	> 2.2	> 0			
	> 2.4	N/A			

Figure 8. Cross-section of Line DP10 with core location





-3t

DELAWARE BAY PROJECT SEDIMENT DESCRIPTION					
Hatch Pattern	Deneity gm/cc	M.an Grain Size, ф m	Basic Soil Description		
	1.0 - 1.4	> 4	Soft Meds, Claye		
	1.4 - 1.6	- 32	Cloys, Sitts Sandy Sit		
	1.6 - 1.8	32 - 22	Ctoyey Sands Silty Sande		
	1.8 - 2.0	23 - 1.2	Sitty Sanda Fine Sande		
	20 - 22	2 - 0	Medium Sande		
	> 2.2	> 0	Coarse Sande & Gravele Clayey Sande w/ Gravele		
	> 2.4	N/A	Rack, Constituted Clays		

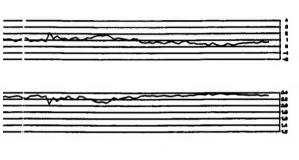
V.C. = 50

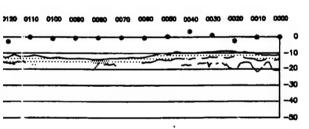
WATERWAYS EXPERIMENT STATIC CORPS OF ENGINEERS VICKSBURG, MS 39180

> DELAWARE BAY PROJECT SEDIMENT PROFILE LINE DP10

FILE NAME: DP10.DWG

SCALE: 1"=1000" DATE: DECEMBER 11, 1985 SHEET





WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180

DELAWARE BAY PROJECT SEDIMENT PROFILE LINE DP10

FILE NAME: DP10.DWG SCALE: 1"-1000" DATE: DECEMBER 11, 1985 SHEET



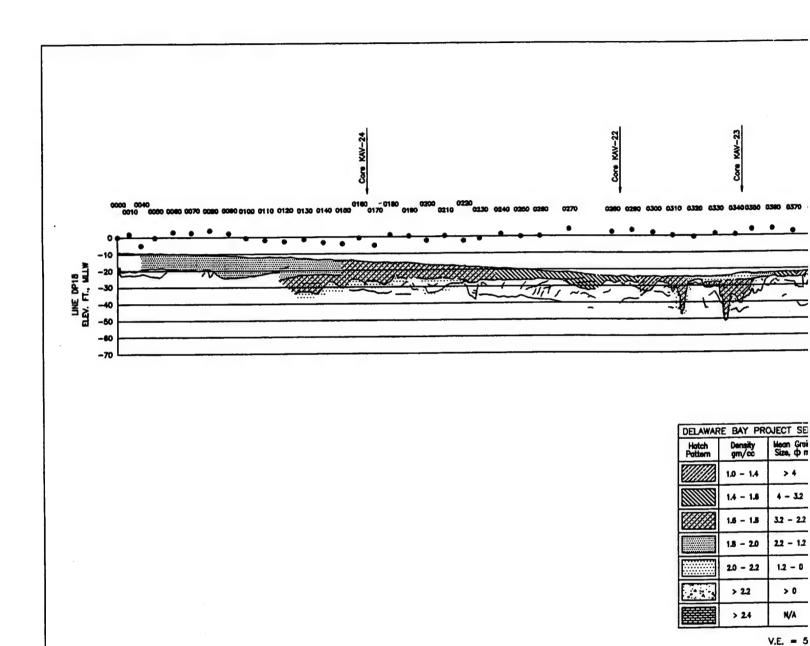


Figure 9. Cross-section of Line DP18 with core locations



Core KAV-23

3 0330 0340 0350 0380 0370 0380 0400 0410 0420 0430 0460 0470 0480 0460 8600 0510 0530 0540 05570 9580 0580 0580 0580 0600 0610 0630 0640 06570 0680 0680

WA	WARE BAY PROJECT SEDIMENT DESCRIPTION					
th m	Density gm/cc	Mean Grain Size, ¢ m	Basic Soil Description			
$\overline{\mathbb{Z}}$	1.0 - 1.4	> 4	Soft Muds, Claye			
	1.4 - 1.6	4 - 3.2	Clays, Situ Sandy Sit			
	1.5 - 1.8	3.2 - 2.2	Clayey Sande Sity Sande			
	1.8 - 2.0	22 - 12	Silty Sande Fine Sands			
	2.0 - 2.2	1.2 - 0	Medium Sanda			
	> 2.2	> 0	Coarse Sands & Gravels Clayey Sands w/ Gravels			
薯	> 2.4	N/A	Rock, Cosolidated Clays			

V.E. = 50

WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180

DELAWARE BAY SEDIMENT PROFILE LINE DP18

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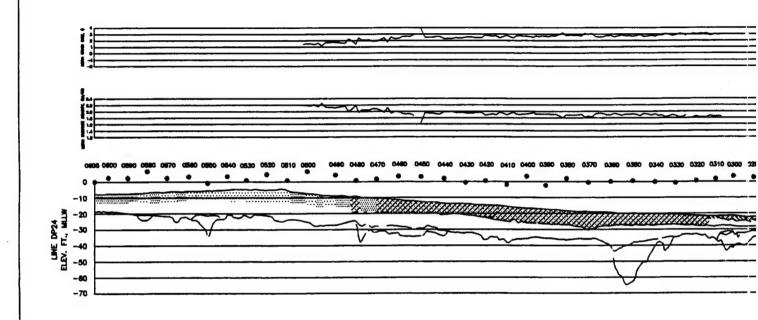
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WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180

DELAWARE BAY SEDIMENT PROFILE LINE DP18

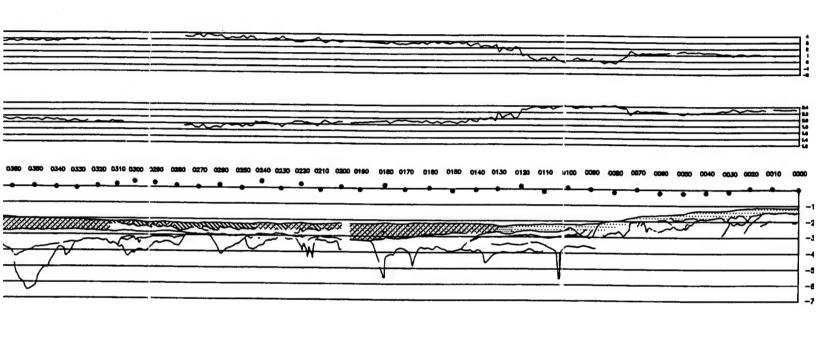
FILE NAME: DP18.DNG SCALE: 1"=1000" DATE: DECEMBER 11, 1995 SHEET



DELAWAR	E BAY PR	DIECT
Hatch Pattern	Density gm/cc	Mean ( Size, c
	1.0 - 1.4	> 4
	1.4 - 1.6	4 - 3
	1.6 - 1.8	3.2
	1.8 - 2.0	22
	2.0 - 2.2	1.2 -
	> 2.2	> 0
	> 2.4	N/A

Figure 10. Cross-section of Line DP	Figure	10	Cross-section	of I	ine D	P24
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DELAWARE BAY PROJECT SEDIMENT DESCRIPTION						
Hatch Pattern	Density gm/cc	Mean Grai Size, $\phi$ n	in Basic Soil Description			
	1.0 - 1.4	>4	Soft Made, Claye			
	1.4 - 1.6	4 - 3.2	Clays, Situ Sandy Silt			
	1.6 - 1.8	32 22	Clayey Sanda Silty Sanda			
	1.8 - 2.0	22 1.2	Sity Sanda Fine Sanda			
*******	20 - 22	1.2 - 0	Medium Sands			
	> 2.2	> 0	Coarse Sande & Gravele Clayey Sande w/ Gravels			
	> 2.4	N/A	Rock, Cosolidated Claye			

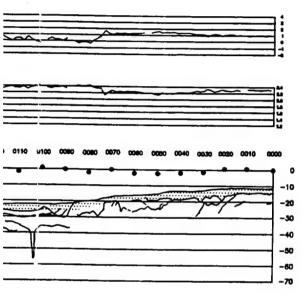
V.E. = 50

WATERWAYS EXPERIMENT S' CORPS OF ENGINEERS VICKSBURG, MS 3918

DELAWARE BAY PROJECT SEDIMENT PROFILE LINE DP24

FILE NAME: DP24.DNO

SCALE: 1°=1000' DATE: DECEMBER 11, 1985 SHEE



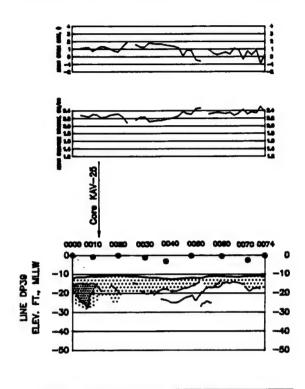
WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180

DELAWARE BAY PROJECT SEDIMENT PROFILE LINE DP24

FILE NAME: DP24.DNQ SCALE: 1°=1000' DATE: DECEMBER 11, 1985 SHEET

23/24





DELAWARE BAY PROJECT SEDIMENT DESCRIPTION						
Hatch Pottern	Density gm/cc	Mean Grain Size, ¢ m	Basic Sail Description			
	1.0 - 1.4	>4	Soft Muds, Claye			
	1,4 - 1,6	4 - 32	Clays, Sits Sandy Sit			
	1.6 - 1.8	32 - 22	Clayey Sands Sity Sands			
	1.8 - 2.0	22 - 12	Silty Sands Fine Sands			
	20 - 22	1.2 - 0	Medium Sande			
	> 2.2	> 0	Coarse Sands & Gravels Clayey Sands 11/ Gravels			
	> 24	N/A	Rook, Constituted Claye			

V.E. = 50

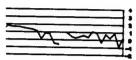
Figure 11. Cross-section of Line DP39 with core location

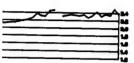
WATERWAYS CORPS VICKSBI

> DEL/WAF SEDIN L

FILE NAME: DP30.DW)







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_					-

CT SED	IMENT DESCRIPTION							
on Grain ≥=, Фm	Boxic Soil Description							
> 4	Soft Made, Clays							
- 3.2	Clays, Sits Sendy Sit							
- 22	Clayey Sands Sity Sands							
- 1.2	Silty Sands Fine Sands							
2 – 0	Medium Sanda							
	Coorse Sanda & Crowsia							

- 50

N/A

WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180

> DELAWARE BAY PROJECT SEDIMENT PROFILE LINE DP39

FILE HAME: DF30.DW1

SOALE: 1"-1000" [ATR: DECEMBER 11, 1986 SHEET

25/26

This core is in the area of the ancestral Primehook River Valley. The upper 2 ft of the core contained sand material, with some shells and gravel-size material. Below 3 ft the sands graded into silt-size material, possibly the lagoonal mud deposits described in the cross-section G-G' in Figure 5.

#### Line DP11

Line DP11 runs perpendicular to the Primehook River valley axis. The cross-section is shown in Figure 12. No cores were taken along this line. The acoustic impedance analysis of the seismic data indicated that all of the surface sediment was medium to fine sands. A deep subbottom reflector in the center of the line may be associated with the ancestral Primehook River Valley. Line G-G' (Figure 5) crosses line DP11 and from that data the subbottom may be composed of fine lagoonal muds under the surficial sands.

### Line DP19

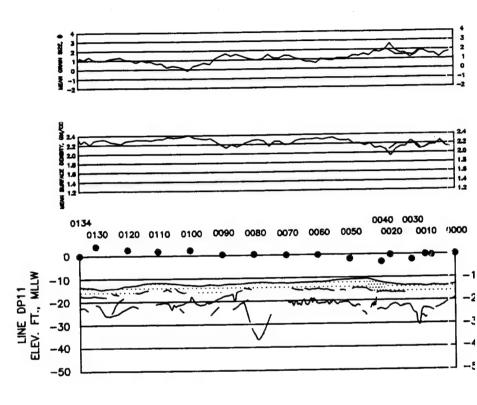
Parallel to line DP11 but further bayward was line DP19. Figure 13 shows the cross-section of Line DP19. No cores were collected along this line and some data was missing from the center of the line. The acoustic signature indicates fine to medium sands in the surficial layer. Again the underlying layers are probably the lagoonal mud deposit of Maley (1981).

### Line DP 25

The most bayward seismic line of this group was Line DP25. Figure 14 shows the cross-section of Line DP25 with core KAV-26. The surficial sediments increase in grain-size from fine silty sand on the landward end to medium sand on the shoal on the bayward end of the line. Core KAV-26 was located on the northeastern end of the line, on the southern edge of the sand shoal next to the ancestral Primehook River Valley. Most of the core contains well sorted sands, with some silt. Some gravel material was found in the lower section of the core.

Chapter 3 Analysis 27



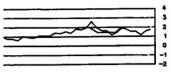


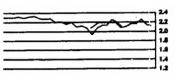
DELAWARE BAY PROJECT SEDIMENT DESCRIPTION							
Hatch Pattern	Density gm/cc	Mean Grain Size, ф m	Basic Soil Description				
	1.0 - 1.4	> 4	Soft Muds, Clays				
	1.4 - 1.6	4 - 3.2	Clays, Silts Sandy Silt				
	1.6 - 1.8	3.2 - 2.2	Clayey Sands Silty Sands				
	1.8 - 2.0	2.2 - 1.2	Silty Sands Fine Sands				
	2.0 - 2.2	1.2 - 0	Medium Sands				
	> 2.2	> 0	Coarse Sands & Gravels Clayey Sands w/ Gravels				
	> 2.4	N/A	Rock, Cosolidated Clays				

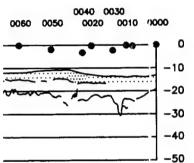
Figure 12. Cross-section of Line DP11

V.E. = 50









### MENT DESCRIPTION

Basic Soil Description

Soft Muds, Clays

Clays, Silts Sandy Silt

Clayey Sands Silty Sands

Silty Sands Fine Sands

Medium Sands

Coarse Sands & Gravels Clayey Sands w/ Gravels

Rock, Cosolidated Clays

WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180

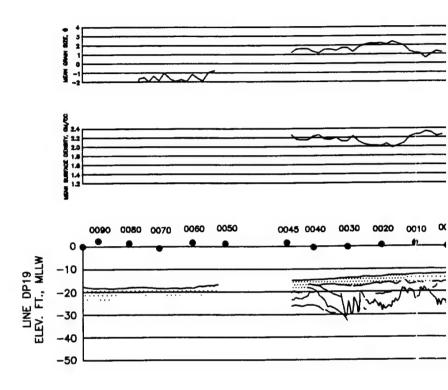
> DELAWARE BAY PROJECT SEDIMENT PROFILE LINE DP11

FILE NAME: DP11.DWG

SCALE: 1"=1000' DATE: DECEMBER 11, 1995 SHEET

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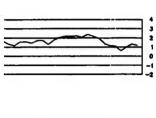


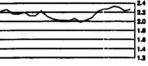
DELAWARE BAY PROJECT SEDIMENT DESCRIPTION							
Hatch Pattern	Density gm/cc	Mean Grain Size, ¢ m	Basic Soil Description				
	1.0 - 1.4	> 4	Soft Muds, Clays				
	1.4 - 1.6	4 - 3.2	Clays, Silts Sandy Silt				
	1.6 - 1.8	3.2 - 2.2	Clayey Sands Silty Sands				
	1.8 - 2.0	2.2 - 1.2	Silty Sands Fine Sands				
	2.0 - 2.2	1.2 - 0	Medium Sands				
	> 2.2	> 0	Coarse Sands & Gravels Clayey Sands w/ Gravels				
	> 2.4	N/A	Rock, Cosolidated Clays				

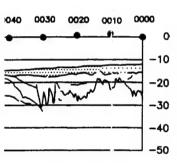
Figure 13. Cross-section of Line DP19

V.E. = 50









IENT DESCRIPTION

Basic Soil
Description

Soft Muds, Clays

Clays, Silts Sandy Silt

Clayey Sands Silty Sands

Silty Sands Fine Sands

Medium Sands

Coarse Sands & Gravels Clayey Sands w/ Gravels

Rock, Cosolidated Clays

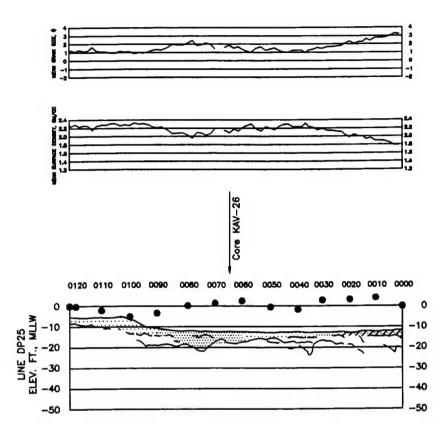
WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180

> DELAWARE BAY PROJECT SEDIMENT PROFILE LINE DP19

FILE NAME: DP19.DWG

SCALE: 1"=1000" DATE: DECEMBER 11, 1995 SHIET





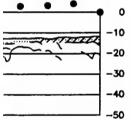
DELAWARE BAY PROJECT SEDIMENT DESCRIPTION							
Hatch Pattern	Density gm/cc	Mean Grain Size, $\phi$ m	Basic Soil Description				
	1.0 - 1.4	> 4	Soft Muds, Clays				
	1.4 - 1.6	4 - 3.2	Clays, Silts Sandy Silt				
	1.6 - 1.8	3.2 - 2.2	Clayey Sands Silty Sands				
	1.8 - 2.0	2.2 - 1.2	Silty Sands Fine Sands				
**********	2.0 - 2.2	1.2 - 0	Medium Sands				
	> 2.2	> 0	Coarse Sands & Gravels Clayey Sands w/ Gravels				
	> 2.4	N/A	Rock, Cosolidated Clays				

Figure 14. Cross-section of Line DP25 with core location

V.E. = 50



0 0030 0020 0010 0000



T DESCRIPTION

Basic Soil
Description

Muds, Clays

I, Silts
ly Silt

sy Sands

Sands

Sands

se Sands & Gravels
ly Sands w/ Gravels

, Cosolidated Clays

WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180

> DELAWARE BAY PROJECT SEDIMENT PROFILE LINE DP25

FILE NAME: DP25.DWG

SCALE: 1"=1000" DATE: DECEMBER 11, 1995 SHEET

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## 4 Summary

Sediment in the lower Delaware Bay is controlled by the geologic processes of the Pleistocene regression and transgression and is modified by present-day coastal processes. The area of potential sand resources has been identified using seismic survey profiles and vibracores. The area identified as containing possible borrow areas is outlined in Figure 15. The thickness ranges from 3 ft on the inshore end to possibly 10 ft on the shoal areas off-shore. The area is characterized by two shoal areas divided by valleys that correspond to pre-Holocene river valleys. These valleys are composed of fine material not suited for beach nourishment. The shoal areas are topographic highs and contain medium to fine sands, that are suitable for consideration to nourish Broadkill Beach.

Chapter 4 Summary

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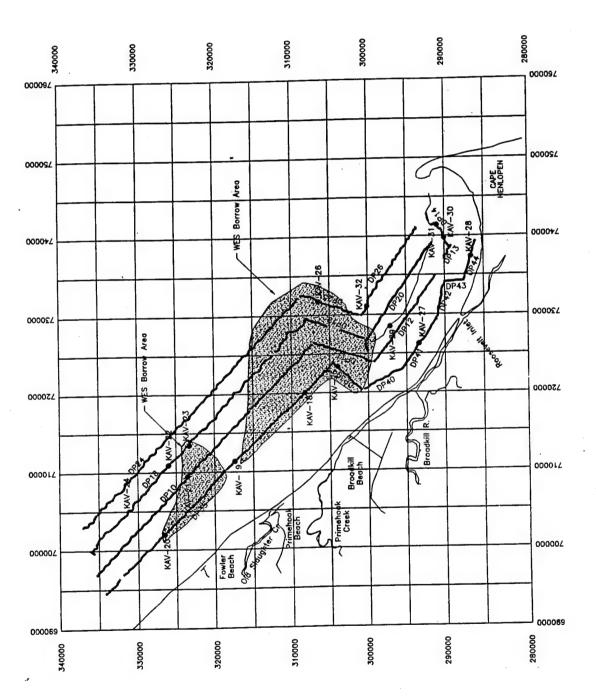


Figure 15. Area of potential sand resources

## References

Fletcher, C.H. III, Knebel, H.J., and Kraft, J.C. (1990). "Holocene evolution of an estuarine coast and tidal wetlands," *Geological Society of America Bulletin* 102, 283-297.

Knebel, H.J., Fletcher, C.H. III, and Kraft, J.C. (1988). "Late Wisconsinan-Holocene paleogeography of Delaware Bay; A large coastal plain estuary," *Marine Geology* 83, 115-133.

Maley, K. (1981). "A transgressive facies model in a shallow estuarine environment: The Delaware Bay nearshore zone, from Beach Plum Island to Fowler Beach," M.S. thesis, Geology Department, University of Delaware, Newark.

McGee, R.G., Ballard, R.F., and Caulfield, D.D. (1995). "A technique to assess the characteristics of bottom and subbottom marine sediments," Technical Report DRP-95-3, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

McGee, R.G. "Geoacoustic study of Delaware River main channel," in preparation, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Wethe, C.A. (1984). "The suitability of offshore sand deposits for use as beach fill at Broadkill Beach," Technical Report WEA-05-84, Delaware Division of Soil and Water Conservation, Dover, DE.

Wethe, C.A., De Sombre, K., Counts, D.M., and Tinsman, C.H. (1982). "Sand sources for the renourishment of Broadkill Beach," Technical Report MSL-01-82, College of Marine Studies, University of Delaware, Lewes.

# Appendix A Core Logs and Gradation Curves

Appendix A contains the core logs and gradation curves supplied by the U.S. Army Corps of Engineers, South Atlantic Division Sediment Laboratory. The core loges list the core length, material description and the location of the sediment samples collected within the core for grain-size analysis and selected samples that were analyzed for density. The gradation curves are provided for each sample analyzed within each core. The sample number and depth range of the channel sample correspond to the listing on the core log comments column.

# DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060



			- INGENERAL PROPERTY	oll SOUTH COBB DRIVE,	MARLE	11A, GA. 30060		
Project: DELAWARE BAY						Boring No. KAV-18		
Locati	ion: VIBI	RA CO	RE SAMPLES	Lab No. 184/925				
Boring	Boring Depth (ft): 15.20 Elevation:					order: 7476		
	/Notes:	See g	rain size data on enclosed	d gradation curves.	Requisi	tion: CENAP-95-707		
Elev. (feet)	Depth (feet)	Leg- end	Ma	terial Description		Comments		
	_					(Density Units = pcf)		
	2 —		TAN, SANDY POORL	Y GRADED GRAVEL (GP).		SA (A) 1.2 - 2.2'		
	3 -		TAN, POORLY GRADE	ED SILTY SAND (SP-SM).		SA D-1 3.0 - 3.5' WET DEN. = 128.9 DRY DEN. = 119.1, MC = 8.2%		
	5 —							
	6 - 7 - 8 - 9 - 10 - 11 - 11 - 1		TAN, GRAVELLY POOR	RLY GRADED SILTY SAND RACE OF MICA.		SA D-2 7.5 - 8.0' WET DEN. = 139.5, DRY DEN. = 132.7, MC = 6.0%		
	12 -		TAN AND GRAY, SILT	TY SAND (SM), WITH A		SA (B) 11.9 - 12.3'  SA D-3 13.3 - 13.9' WET DEN. =		
	14 — 15 — 16 —		LOW LL (ML), WITH	CEOUS INORGANIC SILT A LITTLE SAND SIZES, EDOMINANT BOTTOM 0.4	-	127.1, DRY DEN. = 102.4 MC = 24.2%		
	17 —							

Date: 01/19/95

LABORATORY LOG AND SAMPLE DATUM

Sheet No. 1 of 1

8.0 2 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Lab No. 184/925A Boring No. KAV-18 01/18/95 Project Ы .F. DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY FINE U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 77 GRAIN SIZE IN MILLIMETERS Nat w% SAND MEDIUM SANDY POORLY GRADED GRAVEL GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE 1 3/4 1/2 3/8 GRAVEL (VISUAL) TAN, COARSE (GP) 20 8 1.2-2.2 Depth COBBLES Sample No. 8 8 8 70 2 20 PERCENT FINER BY WEIGHT

PERCENT COARSER BY WEIGHT



PERCENT COARSER BY WEIGHT 2 2 8 2 8 7 8 8 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY 7476 Boring No. KAV-18 184/925 01/18/95 WORK ORDER: Lab No. Date 0.0 200 70 100 140 <u>.</u> 占 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS I 0.5 GRAIN SIZE IN MILLIMETERS 20 Nat w % 30 40 8.2 SAND MEDIUM 8 10 14 16 20 (VISUAL) TAN, POORLY GRADED SILTY SAND GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES (SP-SM). SP. GRAVITY = 2.64 WET DENSITY = 128.9 PCF. DRY DENSITY = 119.1 PCF. Classification FINE 1/2 3/8 GRAVEL 1 3/4 COARSE 8 3.0-3.5 Depth COBBLES Sample No. ۵ <u>6</u> 8 8 2 2 8 <del>\$</del> PERCENT FINER BY WEIGHT



PERCENT COARSER BY WEIGHT 0.00 100.0 8 8 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES HYDROMETER SILT OR CLAY DELAWARE BAY Boring No. KAU-18 01/18/95 Lab No. 184/925 Z 50 70 100 140 <u>.</u> DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY Ы U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 GRAIN SIZE IN MILLIMETERS
SAND
MEDIUM
FIN 1 Nat w % 용 0.9 9 SILTY SAND (SP-SM). WITH A TRACE OF MICA 8 10 14 16 20 (VISUAL) TAN, GRAVELLY PODRLY GRADED GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES WEY DENSITY = 139.5 PCF. DRY DENSITY = 132,7 PCF. Classification FINE SP. GRAVITY = 2.66 1 3/4 1/2 3/8 GRAVEL COARSE S 8 7.5-8.0 Depth COBBLES Sample No. 녂휞 D-7 8 8 8 2 8 S 3 20 2 PERCENT FINER BY WEIGHT



PERCENT COARSER BY WEIGHT 9.00 8.00 8 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 HYDROMETER SILT OR CLAY DELAWARE BAY Lab No. 184/925B Boring No. KAV-18 01/18/95 0.1 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS 7 FINE ORAIN SIZE IN MILLIMETERS 1 <del>2</del> SAND MEDIUM 8 10 14 16 20 (VISUAL) TAN AND GRAY, SILTY SAND (SM), GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES AITH A LITTLE GRAVEL SIZES. 1/2 3/8 FINE GRAVEL COARSE ೪ 8 11.9-12.3 Depth COBBLES Sample No. 8 8 70 8 2 20 0 PERCENT FINER BY WEIGHT

PERCENT COARSER BY WEIGHT 0.00 100.0 MORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES HYDROMETER SILT OR CLAY DELAWARE BAY Lab No. 184/925 Boring No. KAV-18 01/19/95 Project Date Z 140 0.1 70 100 F DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 ORAIN SIZE IN MILLIMETERS 1 Nat w% 5 (VISUAL) TAN & GRAY, MICACEDUS INDRGANIC 24.2 SAND 8 SILI LOW LL (ML). WITH A LITLE SAND SIZES SP. GRAVITY = 2.69 MEDIUM 10 1416 20 GRADATION CURVES CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES JET DENSITY = 127.1 PCF. DRY DENSITY = 102.4 PCF Classification FINE 1/2 3/8 GRAVEL 3/4 COARSE S 8 13.3-13.9' Depth COBBLES Sample No. 卢홍 2 8 8 8 8 8 \$ 2 PERCENT FINER BY WEIGHT



# DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060



				611 SOUTH COBB DRIVE,	MARIET	TA, GA. 30060		
Project: DELAWARE BAY					Boring No. KAV-19			
Location: VIBRA CORE SAMPLES  Boring Depth (ft): 17.60 Elevation:						Lab No. 184/926		
						rder: 7476		
		_	rain size data on enclose	d gradation curves.	Requisit	tion: CENAP-95-707		
Elev. (feet)	Depth (feet)	Leg- end	Ma	terial Description		Comments		
	1 - 2 - 3 - 3		(SP-SM), WITH A	ORLY GRADED SILTY SAND LITTLE GRAVEL SIZES.		(Density Units = pcf  SA D-12.3 - 2.9 WET DEN. = 125  DRY DEN = 114.0, MC = 13.3 %		
	5 —		TANNISH GRAY, SIL	TY SAND (SM).		SA (A) 3.7 - 4.0		
	6 — 7 — 8 — 9 —		H TRHCE OF MICH.	SILTY SAND (SM), WITH		SA D-2 7.1 - 7.6' WET DEN. = 111 DRY DEN. = 93.7, MC = 18.5 %.		
1 1	110 — 111 — 12 — 13 — 4 — 5 — 1		TAN AND TANNISH GR WITH A TRACE OF MI	AY, SILTY SAND (SM), CA.	-	SA D-3 12.5 - 13.0' WET DEN. = 120.4, DRY DEN = 99.0, MC = 21.6 %. SA (C) 13.7 - 14.0'		
	6 -	-		·		SA D-4 16.0 - 16.5' WET DEN = 120.6, DRY DEN = 99.3. MC = 21.4 %. SA (D) 17.3 - 17.6'		

Date: 01/25/95

LABORATORY LOG AND SAMPLE DATUM

Sheet No. / of /

0.00 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY 0.01 Boring No. KAV-19 Lab No. 184/926 0.05 200 8 10 14 16 20 30 40 50 70 100 140 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CAPPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS 7 Nat w % 13.3 MEDIUM SILTY SAND (SP-SM), WITH A LITTLE GRAVEL SP. GRAVITY = 2.63 GRADATION CURVES (VISUAL) TAN & GRAY, POORLY GRADED COARSE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 129.1 PCF. DRY DENSITY = 114.0 PCF. Classification FINE 1/2 3/8 2 GRAVEL COARSE SIZES. S 2.3-2.9 Depth COBBLES Sample No. 5 <u>801</u> . 8 80 70 8 2 20 PERCENT FINER BY WEIGHT

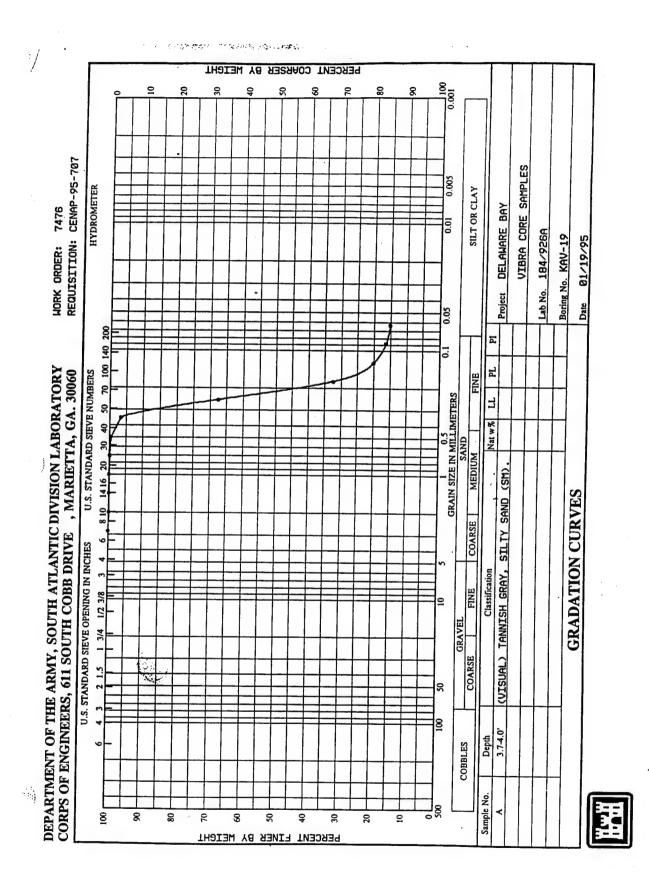
PERCENT COARSER BY WEIGHT



01/19/95

Date

Report Carrier



8 9 20 WORK ORDER: 7476 REDUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.00 HYDROMETER SILT OR CLAY DELAWARE BAY Boring No. KAV-19 Lab No. 1847926 0.0 200 70 100 140 굺 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS ⊒ Nat w % MEDIUM 8 10 14 16 20 (VISUAL) LT. GRAY & TAN, SILTY SAND GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE (SM). WITH A TRACE OF MICA. U.S. STANDARD SIEVE OPENING IN INCHES LET DENSITY = 111.0 PCF. DRY DENSITY = 93,7 PCF. Classification FINE SP. GRAVITY = 2.64 COARSE S 7.1-7.6 Depth COBBLES Sample No. 27 8 8 80 70 8 S 8 2 20 PERCENT FINER BY WEIGHT

PERCENT COARSER BY WEIGHT



01/19/95

Date

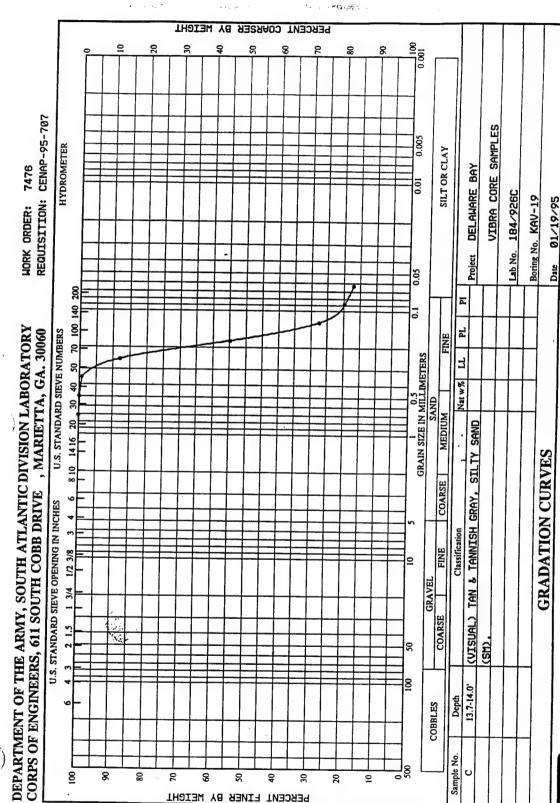
174428<sup>215</sup>7 PERCENT COARSER BY WEIGHT 0.001 8 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Lab No. 184/926B Boring No. KRV-19 01/19/95 Z 5 5 PL 001 07 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 GRAIN SIZE IN MILLIMETERS
SAND
MEDIUM
FIN 11 Nat w % (VISUAL) TAN & TANNISH GRAY, SILTY SAND 8 10 14 16 20 GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES FINE GRAVEL COARSE (SH) တ္တ 8 8.6-8.9 Depth COBBLES Sample No. œ 8 3 2 8 8 5 જ S \$ PERCENT FINER BY WEIGHT



8 **\$** 20 8 8 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 SILT OR CLAY HYDROMETER DELAWARE BAY 7476 Boring No. KRV-19 Lab No. 184/928 01/19/95 WORK ORDER: Date 3 .. 0 70 100 F DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY FINE U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 1 I 0.5 GRAIN SIZE IN MILLIMETERS Nat w % 21.6 SAND MEDIUM GRADATION CURVES (VISUAL) TAN & TANNISH GRAY, SILTY COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES SM). WITH A TRACE OF MICA. SP. GRAVITY = 2.64 WET DENSITY = 120.4 PCF. DRY DENSITY = 99.0 PCF. FINE 1/2 3/8 S 8 12.5-13.0 Depth COBBLES Sample No. 53 20 8 8 2 8 8 30 PERCENT FINER BY WEIGHT

РЕЯСЕИТ СОАЯЗЕЯ ВУ МЕТСНТ







DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE

WORK ORDER: 7476 REQUISITION: CENAP-95-707 SILT OR CLAY HYDROMETER 0.05 <u>.</u> ₹ 70 100 U.S. STANDARD SIEVE NUMBERS ORAIN SIZE IN MILLIMETERS
SAND MEDIUM COARSE U.S. STANDARD SIEVE OPENING IN INCHES FINE 1 3/4 1/2 3/8 COARSE S 8 COBBLES

8

PERCENT FINER BY WEIGHT

PERCENT COARSER BY WEIGHT VIBRA CORE SAMPLES DELAWARE BAY Boring No. KAV-19 Lab No. 184/926 01/19/95 3 Nat w % 21.4 (VISUAL) TAN & TANNISH GRAY, SILTY SAND GRADATION CURVES (SM), WITH A TRACE OF MICA. WET DENSITY = 120.8 PCF. DRY DENSITY = 99.3 PCF. SP. GRAVITY = 2.64 16.0-16.5 Depth Sample No. 7

2



8

8

8

2

PERCENT COARSER BY WEIGHT 20 2 REGUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 HYDROMETER SILT OR CLAY 7476 DELAWARE BAY Lab No. 184/926D Boring No. KAU-19 01/19/95 WORK ORDER: 140 200 H 0.1 50 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS FINE GRAIN SIZE IN MILLIMETERS SAND 7 5 Nat w% MEDIUM SAND (VISUAL) TAN & TANNISH GRAY, SILTY GRADATION CURVES COARSE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE 1/2 3/8 GRAVEL COARSE (SM) S 8 17.3-17.6 Depth COBBLES Sample No. 8 8 Ω 8 70 8 S 6 30 20 PERCENT FINER BY WEIGHT

## DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060

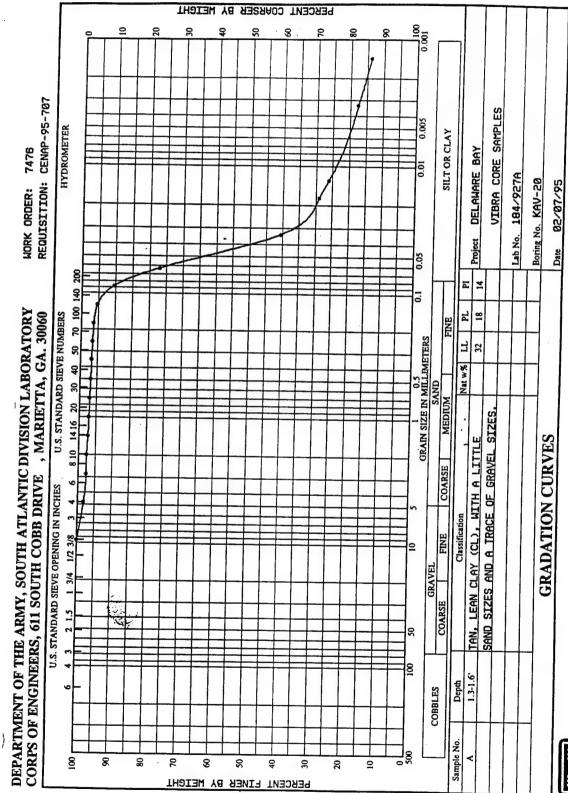


		COI	RPS OF ENGINEERS, 611 SOUTH COBB DE	ave,	MARIET	TA, GA. 30060		
Project: DELAWARE BAY Bori						ng No. KAV-20		
Location: VIBRA CORE SAMPLES Lat						Lab No. 184/927		
Boring Depth (ft): 16.00 Elevation: Work						rder: 7476		
Datum	/Notes:	See gr	ain size data on enclosed gradation curves.		Requisit	ion: CENAP-95-707		
Elev. (feet)	Depth (feet)	Leg- end	Material Description			Comments		
	1 - 2 -		GRAY, GRAVELLY SILTY SAND (SM).  TAN, LEAN CLAY (CL), WITH A LITTLE SIZES AND A TRACE OF GRAVEL SIZES.	E SANI	 ) ·	MA ATT (A) 1.3 - 1.6'  MA D-1 2.5 - 3.0' WET DEN = 12		
	3 — 4 — 5 — 6 —		TAN, LEAN CLAY (CL), WITH SOME SAN	ND SIZ	ES.	DRY DEN = 95.1, MC = 27.9 %.  MA ATT (B) 4.0 - 4.3'		
	7 — 8 — 9 —		TAN, SANDY INORGANIC SILT LOW LL C	(ML).		MA D-2 7.3 - 7.8' WET DEN = 11 DRY DEN = 92.7, MC = 27.2 %.		
	10 —		LT. GRAY, SILTY SAND (SM).		-	MA D-3 12.3 - 12.8' WET DEN = 119.3, DRY DEN = 96.1, MC = 24.2 %.		
	14 — 15 — 16 — 17 —				-	MA (C) 14.6 - 14.9		

Date: 03/13/95

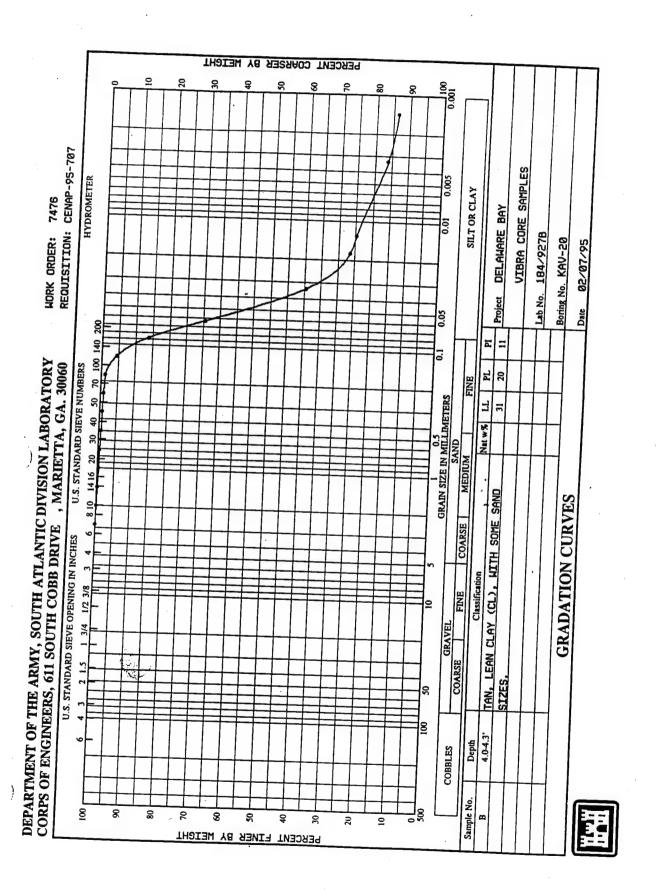
LABORATORY LOG AND SAMPLE DATUM

Sheet No. 1 of 1



PERCENT COARSER BY WEIGHT 9 ន REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY 7476 Boring No. KAV-20 02/07/95 Lab No. 184/927 WORK ORDER: Date 0.05 140 200 <u>.</u> PL 50 70 100 FINE DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY U.S. STANDARD SIEVE NUMBERS . MARIETTA, GA. 30060 금 GRAIN SIZE IN MILLIMETERS Nat w % 27.9 SAND MEDIUM (ML), MICACEOUS WITH A LITTLE SAND SIZES. SP. GRAVIIY = 2.66 8 10 14 16 20 GRADATION CURVES (VISUAL) TAN, INDRGANIC SILT LOW LI COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES DRY DENSITY = 95.1 PCF. WET DEN = 121.6 PCF. 1 3/4 1/2 3/8 GRAVEL COARSE 8 Depth 2.5-3.0° COBBLES Sample No. 7 20 8 8 8 2 S PERCENT FINER BY WEIGHT



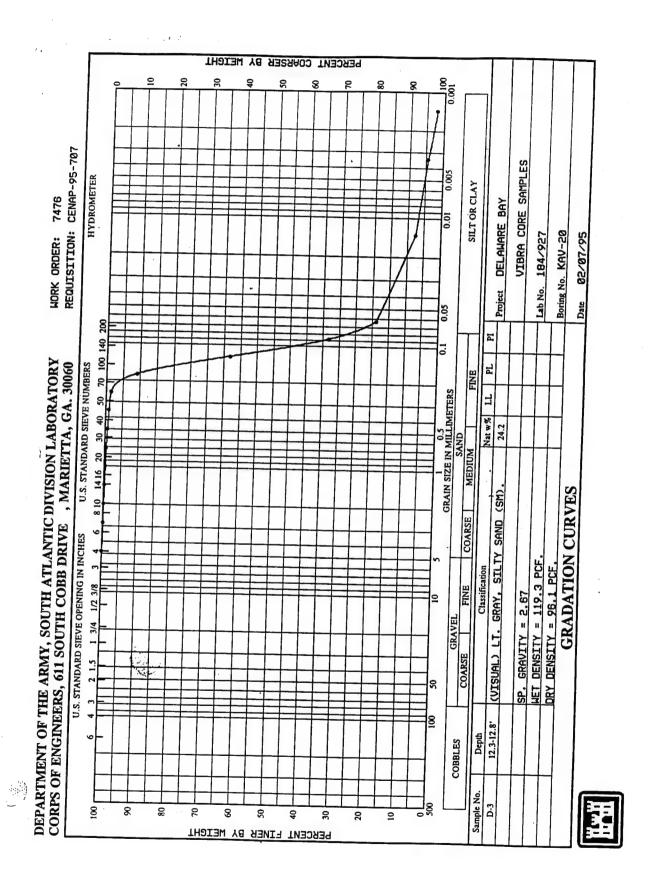


PERCENT COARSER BY WEIGHT 8 0.001 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 HYDROMETER SILT OR CLAY DELAWARE BAY 0.01 Boring No. KAV-20 Date 03/13/95 Lab No. 184/927 WORK ORDER: 0.05 3 0.1 70 100 PL. DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS : Nat w % 27.2 MEDIUM (VISUAL) TAN, MICACEOUS INORGANIC SILT GRADATION CURVES OW LL (ML), WITH SOME SAND SIZES, COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES SP. GRAVITY = 2.67 WET DENSITY = 117.9 PCF. DRY DENSITY = 92.7 PCF. Classification FINE 1 3/4 1/2 3/8 GRAVEL COARSE ಜ 8 7.3-7.8 Depth COBBLES Sample No. 김홍 D-2 8 8 8 5 જ 20 **\$** 30 2 2 PERCENT FINER BY WEIGHT

Arrest .

388 J. Physik





PERCENT COARSER BY WEIGHT 0.001 2 8 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 HYDROMETER SILT OR CLAY DELAWARE BAY 0.01 Lab No. 184/927C Boring No. KAV-20 02/07/95 0.05 Ы 70 100 140 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY ЪΓ , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS FINE GRAIN SIZE IN MILLIMETERS 1 Nat w % MEDIUM **GRADATION CURVES** (VISUAL) LT. GRAY, SILTY SAND (SA) COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE GRAVEL 1 3/4 COARSE ಜ 8 14.6-14.9" Depth COBBLES Sample No. 8 \$ 8 2 8 2 20 PERCENT FINER BY WEIGHT



# DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060



TAN, POORLY GRADED SAND (SP), WITH A TRACE OF MICA AND SHELL FRAGMENTS.  SA D-1 2.1-2.6' WET DEN DRY DEN = 106.5, MC = 7.5 %.  SA (A) 4.0-4.3'  SA (B) 5.6-5.9'  GRAY, SILTY SAND (SM).				611 SOUTH COBB DRIVE	, MAKIE	TTA, GA. 30060	
Boring Depth (fi): 17.30 Elevation: Work order: 7476  Datum/Notes: See grain size data on enclosed gradation curves. Requisition: CENAP-95-707  Elev. Depth (feet) Leg cnd Material Description Comments  1				Boring	Boring No. KAV-21		
Datum/Notes: See grain size data on enclosed gradation curves.  Eliev. Depth (feet) (feet) (feet) end Material Description  TAN, POORLY GRADED SAND (SP), MITH A TRACE OF MICA AND SHELL FRAGMENTS.  SA D-1 2.1-2.6' WET DEN - DRY DEN = 106.5, MC = 7.3 %.  SA (A) 4.0-4.3'  SA (B) 5.6-5.9'  TAN AND LT. BROWN, POORLY GRADED SAND  (SP).  GRAY, SILTY SAND (SM).  SA (B) 5.6-5.9'  SA (B)	Location: VIB	RA CO	RE SAMPLES	Lab N	Lab No. 184/928		
Elev. (feet) Comments    Comments	Boring Depth	(ft): 1	7.30	Work	order: 7476		
(feet) (feet) end Material Description Comments  1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1			rain size data on enclose	d gradation curves.	Requis	ition: CENAP-95-707	
TAN, POORLY GRADED SAND (SP), WITH A TRACE OF MICA AND SHELL FRAGMENTS.  SA D-1 2.1-2.6 WET DEN DRY DEN = 106.5, MC = 7.5 %.  SA (A) 4.0-4.3 SA (A) 4.0-4.3 SA (B) 5.6-5.9			Ma	sterial Description		0	
13 — 14 — 15 — TAN, POORLY GRADED SILTY SAND (SP-SM).  SA D-3 12.6 - 13.1' WET DEN = 124.1, DRY DEN = 103.1, MC = 20.4 %.  SA D-3 12.6 - 13.1' WET DEN = 124.1, DRY DEN = 103.1, MC = 20.4 %.  SA (E) 16.0 - 16.3'	1 — 2 — 3 — 4 — 5 — 6 — 7 — 10 — 11 — 12 — 13 — 14 — 15 — 16 — 16 — 16 — 16 — 16 — 16 — 16		TAN, POORLY GRAD TRACE OF MICA AND TRACE OF MICA AND TAN AND LT. BROWN (SP).  GRAY, SILTY SAND LENSES OF POORLY ( AND OCCASIONAL POOR BROWNISH GRAY, SIL GRAVEL SIZES AND A FRAGMENTS.	ED SAND (SP), WITH A D SHELL FRAGMENTS.  J, POORLY GRADED SAND  (SM), WITH POCKETS AND GRADED SILTY SAND (SP-CKETS OF PLASTIC FINES  TY SAND (SM), WITH SOUTH SOUTH SAND (SM), WITH SA	SM) -	(Density Units = pcf)  SA D-1 2.1-2.6' WET DEN = 114.5 DRY DEN = 106.5, MC = 7.5 %.  SA (A) 4.0-4.3'  SA (B) 5.6-5.9'  SA D-2 7.0-7.5' WET DEN = 120.0 DRY DEN = 95.1, MC = 26.2 %. MA (C) 8.2-8.5'  SA (D) 11.3-11.6'  SA D-3 12.6-13.1' WET DEN = 124.1, DRY DEN = 103.1, MC = 20.4 %.	

Date: 01/25/95

LABORATORY LOG AND SAMPLE DATUM

Sheet No. 1 of 1

PERCENT COARSER BY WEIGHT 0.001 2 8 MORK ORDER: 7476 REQUISITION: CENAP-95-707 SAMPLES 0.005 SILT OR CLAY HYDROMETER VIBRA CORE DELAWARE Lab No. 184/928 Boring No. KAV-21 01/19/95 Date 200 140 교 20 100 FINE DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS 님 GRAIN SIZE IN MILLIMETERS Nat w% \$ SAND 30 ITH A IRACE OF MICA AND SHELL FRAGMENTS. MEDIUM 8 10 14 16 20 (VISUAL) TAN, POORLY GRADED SAND (SP), GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 114.5 PCF. Classification ORY DENSITY = 106.5. FINE SP. GRAVITY = 2.66 1 3/4 1/2 3/8 GRAVEL COARSE 2.1-2.6 Depth COBBLES Sample No. 윽ᅘ 급 2 9 20 40 8 8 8 2 8 PERCENT FINER BY WEIGHT



化物理物质 经分分元 PERCENT COARSER BY WEIGHT 0.0 0.00 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.00 HYDROMETER SILT OR CLAY 7476 DELAWARE BAY Lab No. 184/928A Boring No. KRV-21 01/19/95 WORK ORDER: Project Date 70 100 140 200 Z 0.1 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY 긺 , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS FINE GRAIN SIZE IN MILLIMETERS
SAND
MEDIUM
FINA 1 S **4** Nat w % GRADATION CURVES (VISUAL) TAN AND LT. BROWN, POORLY COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE 1 3/4 1/2 3/8 SRADED SAND (SP). COARSE 20 Depth 4.0-4.3\* COBBLES Sample No. નેષ્ટ 8 8 80 8 20 5 20 2 PERCENT FINER BY WEIGHT



PERCENT COARSER BY WEIGHT <u>8</u>... WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES HYDROMETER SILT OR CLAY DELAWARE BAY Lab No. 184/928B 01/19/95 Boring No. KAV-21 Project Date 5 8 , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS ORAIN SIZE IN MILLIMETERS Nat w% SAND (VISUAL) TAN AND LT. BROWN, POORLY GRADED MEDIUM GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE SILTY SAND (SP-SM), 1/2 3/8 GRAVEL 1 3/4 ಬ 5.6-5.9 Depth COBBLES Sample No. 9 8 8 80 70 8 PERCENT FINER BY WEIGHT



<u>...</u>

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY

PERCENT COARSER BY WEIGHT 9 2 8 2 8 WORK ORDER: 7476 REQUISITION: CENAP-95-707 **VIBRA CORE SAMPLES** HYDROMETER SILT OR CLAY DELAWARE BAY Lab No. 184/928 01/19/95 Boring No. KAV-21 0.05 <del>.</del> 8 10 14 16 20 30 40 50 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS I 0.5 GRAIN SIZE IN MILLIMETERS 1 Nat w % 26.2 SAND MEDIUM GRADATION CURVES COARSE (VISUAL) GRAY, SILTY SAND (SM) CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 120.0 PCF. DRY DENSITY = 95,1 PCF. FINE SP. GRAVITY = 2.65 1 3/4 1/2 3/8 10 COARSE ೪ 7.0-7.5 Depth COBBLES Sample No. D-2 8 80 70 8 20 8 2

PERCENT FINER BY WEIGHT



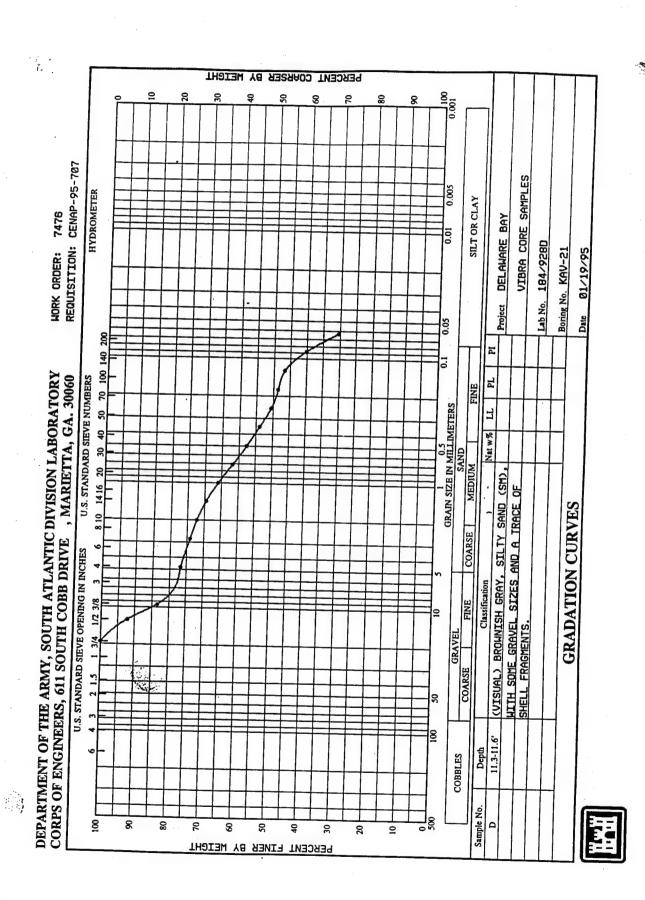
PERCENT COARSER BY WEIGHT REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 HYDROMETER SILT OR CLAY DELAWARE BAY 184/928C Boring No. KAV-21 01/19/95 Lab No. 50 70 100 140 , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS FINE 1 0.5 GRAIN SIZE IN MILLIMETERS SAND 二 \$ 7 MEDIUM (VISUAL) GRAY, INDRGANIC SILT LOW LL GRADATION CURVES (ML), WITH A LITTLE SAND SIZES, COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE GRAVEL COARSE 100 8.2-8.5 Depth COBBLES Sample No. 201 8 8 8 PERCENT FINER BY WEIGHT



7476

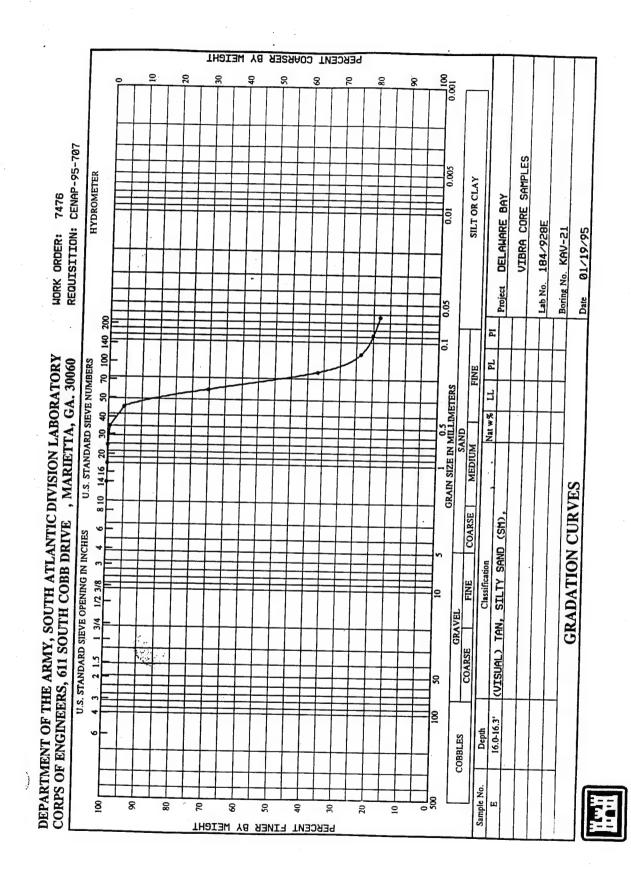
WORK ORDER:

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY



PERCENT COARSER BY WEIGHT 8 8 9 20 VIBRA CORE SAMPLES WORK ORDER: 7476 REQUISITION: CENAP-95-707 SILT OR CLAY HYDROMETER DELAWARE BAY Lab No. 184/928 Boring No. KAV-21 01/19/95 Date 0.05 Ы 200 140 PL FINE 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 GRAIN SIZE IN MILLIMETERS 님 40 50 Nat w % 20.4 3 MEDIUM 8 10 14 16 20 GRADATION CURVES (VISUAL) TAN, POORLY GRADED SILTY COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 124.1 PCF. DRY DENSITY = 103.1 PCF Classification FINE SAND (SP-SM). SP. GRAVITY = 2.64 1 3/4 1/2 3/8 GRAVEL COARSE 8 12.6-13.1 Depth COBBLES Sample No. D-3 10 30 20 8 8 40 2 8 80 8 PERCENT FINER BY WEIGHT







			KI'S OF ENGINEERS,	611 SOUTH COBB DRIVE,	MARIE	1A, GA. 30000			
Project: DELAWARE BAY						Boring No. KAV-22			
Location: VIBRA CORE SAMPLES						Lab No. 184/929			
Boring Depth (ft): 10.20 Elevation:					Work order: 7476				
Datum	Datum/Notes: See grain size data on enclosed gradation curves.			Requisition: CENAP-95-707					
Elev. (feet)	Depth (feet)	Leg- end	Ma	terial Description	Comments				
						(Density Units = pcf)			
	1 —			RUN # 2	1	MA (A) 0.9 - 1.2'			
	2 —		TAN AND BROWNISH WITH PLASTIC FIN	GRAY, SILTY SAND (SM)	•	121 (1) 0.5-1.2			
	3 —					SA D-1 2.2 - 2.7' WET DEN = 118. DRY DEN = 95.1, MC = 24.6 %.			
	4		GRAY, SANDY TNOR	SANIC SILT LOW LL (ML).					
	4 —				1	MA (B) 3.8 - 4.1'			
	_ 1								
	5 —								
1	6 —		LT. GRAY, SILTY S	SAND (SM).					
i	4	Ì			1	SA (C) 6.0 - 6.3			
	7 -								
	-								
	8 —					MA D-2 8.2 - 8.6' WET DEN = 106.			
İ	9 —					DRY DEN = 67.7, MC = 56.8 %.			
			CDAY: THORCALITA O	TI T 117011 1 1 2010 1 10711					
	10		LITTLE SAND SIZES	ILT HIGH LL (MH), WITH AND A TRACE OF MICA.					
	11								
	+	1	y 4 <del>-</del>						
	12				İ				
	13								
	-	Ì							
	14								
	_ +								
	15								

Date: 01/20/95

LABORATORY LOG AND SAMPLE DATUM

Sheef No. / of /



Project: DELAWARE BAY					Boring No. KAV-22		
Location: VIBRA CORE SAMPLES					Lab No. 184/929		
Boring Depth (ft): 15.20 Elevation:				,	Work order: 7476		
Datum/Notes: See grain size data on enclosed gra			rain size data on enclosed gradation curves.	F	Requisition: CENAP-95-707		
Elev. (feet)	Depth (feet)	Leg- end					
					_	Comments  (Density Units = pcf)	
	1 -		RUN # 1			per,	
	- 1						
	2 —		-				
	-					1	
	3 —						
	. 1						
	4					·	
	5 —						
		1					
1	6						
	4				- }-		
	7					SA D- $\frac{1}{3}$ 7.0 - 7.5' WET DEN = 12	
	- 1					DRY DEN = 113.2, MC = 13.3 %.	
	8					Me = 13.3 %.	
	9 —		TAN PORRI V CRAPER OT THE CAND				
			TAN, POORLY GRADED SILTY SAND (S WITH A TRACE OF GRAVEL SIZES.	SP-SM),		SA (D) 9.0 - 9.3'	
1	0						
	4						
1	11						
1.	2						
13	3 —						
	4						
14	4					SA D-4 13.5 - 14.0' WET DEN = 119.7,	
	-		TAN, POORLY GRADED SAND (SP), WIT	TH SOME		DRY DEN = $112.0$ , MC = $6.9$ %.	
15	5	-	GRAVEL SIZES.				
	7						

Date: 01/20/95

LABORATORY LOG AND SAMPLE DATUM

Sheet No. 1 of 1

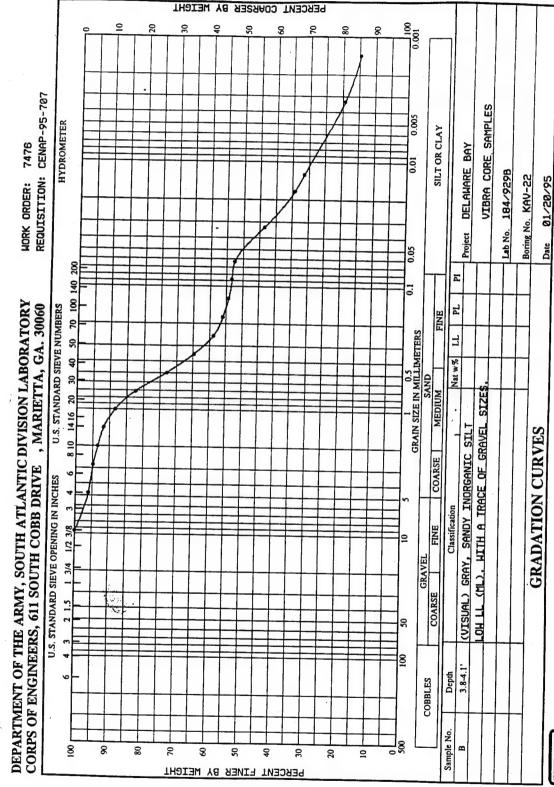
19

PERCENT COARSER BY WEIGHT 0.001 2 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES HYDROMETER SILT OR CLAY DELAWARE BAY Lab No. 184/929A Boring No. KAV-22 01/25/95 Project Ы 70 100 140 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS 1 40 50 Nat w % SAND MEDIUM 8 10 14 16 20 (VISUAL) TAN & BROWNISH GRAY, SANDY GRADATION CURVES COARSE U.S. STANDARD SIEVE OPENING IN INCHES INORGANIC SILI LOW LL (ML). 1 3/4 1/2 3/8 Depth 0.9-1.2 COBBLES Sample No. 8 8 8 70 8 PERCENT FINER BY WEIGHT

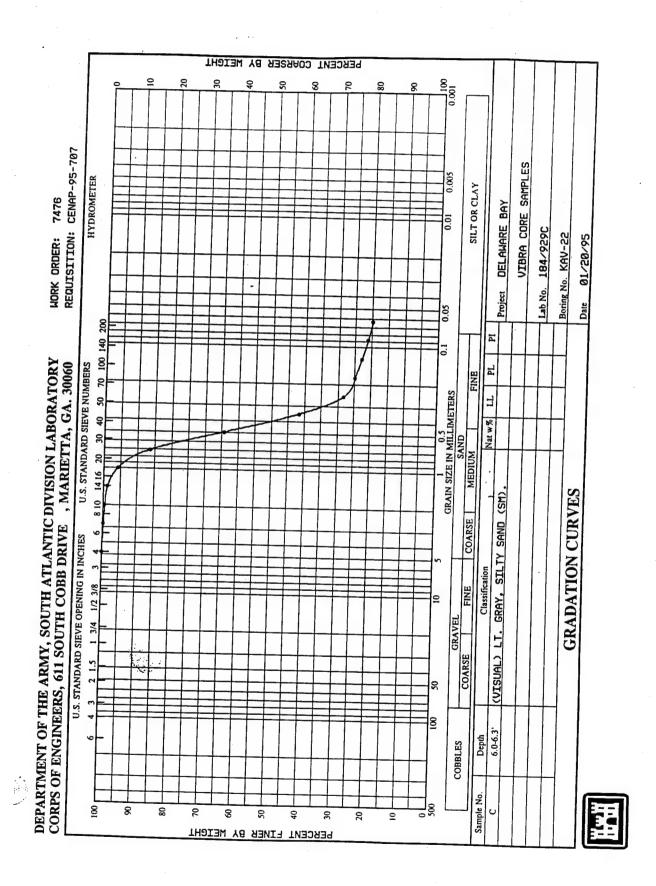


PERCENT COARSER BY WEIGHT 8 REGUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY 7476 0.01 Boring No. KAU-22 184/929 01/20/95 WORK ORDER: Lab No. Project 0.0 ₹ 70 100 7 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 GRAIN SIZE IN MILLIMETERS Ľ Nat w% 24.6 **\$** SAND MEDIUM ITTLE GRAVEL SIZES AND A IRACE OF MICA. 8 10 14 16 20 (VISUAL) GRAY, SILTY SAND (SM), WITH A GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 118.5 PCF. DRY DENSITY = 95.1 PCF. Classification FINE SP. GRAVITY = 2.62 GRAVEL COARSE 20 8 2.2-2.7 Depth COBBLES Sample No. ō 8 8 6 30 20 2 70 8 50 8 PERCENT FINER BY WEIGHT









0.00 100.0 2 20 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Boring No. KAV-22 Lab No. 184/929 01/20/95 WORK ORDER: 5 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 FINE U.S. STANDARD SIEVE NUMBERS 1 0.5 GRAIN SIZE IN MILLIMETERS ๘ 8 Nat was 13.3 SAND WET DEN. = 128.3 PCF MEDIUM 8 10 14 16 20 (VISUAL) TAN, POORLY GRADED SILTY SAND (SP-SM). WITH A TRACE OF GRAVEL SIZES. GRADATION CURVES COARSE U.S. STANDARD SIEVE OPENING IN INCHES SP. GRAVITY = 2.64 WET DRY DENSITY = 113.2 PCF. FINE COARSE S 7.0-7.5 Depth COBBLES Sample No 53 8 8 80 2 8 20 40 8 20 2 PERCENT FINER BY WEIGHT



7476

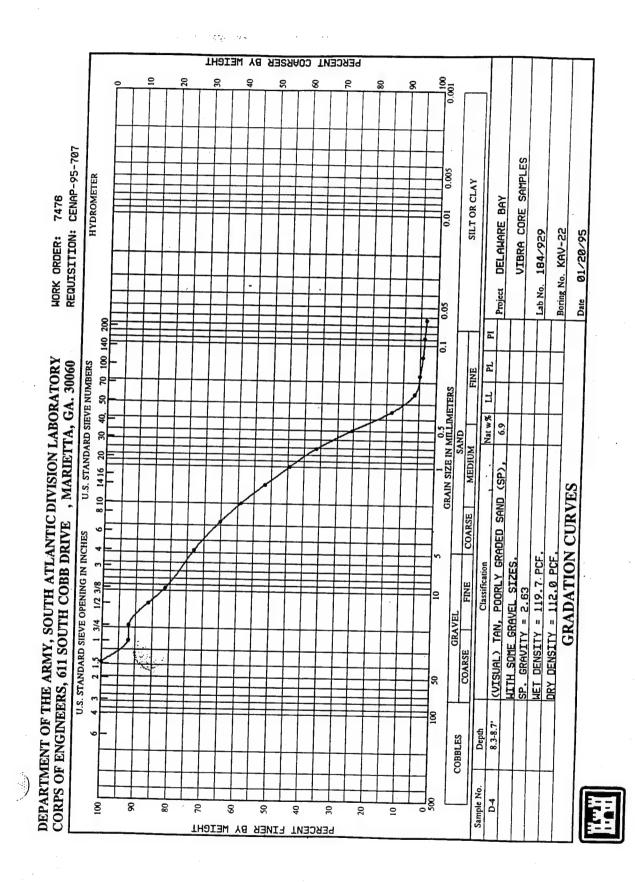
PERCENT COARSER BY WEIGHT 0.0010 WORK ORDER: 7476 REGUISITION: CENAP-95-707 VIBRA CORE SAMPLES HYDROMETER SILT OR CLAY DELAWARE BAY Boring No. KAV-22 01/20/95 184/929 Lab No. 0.05 5 0. 8 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 FINE GRAIN SIZE IN MILLIMETERS 7 **4** Nat w % 56.8 MEDIUM (MH). WITH A LITTLE SAND SIZES AND A IRACE OF MICA. SP. GRAVITY = 2.69 (VISUAL) GRAY, INORGANIC SILT HIGH LL GRADATION CURVES CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 106.2 PCF DRY DENSITY = 67.7 PCF. Classification FINE GRAVEL COARSE 8 8 8.2-8.6 Depth COBBLES Sample No. ြီ 0.7 8 8 20 20 2 PERCENT FINER BY WEIGHT



PERCENT COARSER BY WEIGHT WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Lab No. 184/929D Boring No. KAV-22 01/20/95 0.05 5 F 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS 1 0.5 GRAIN SIZE IN MILLIMETERS SAND 금 40 50 Nat w % 8 10 14 16 20 30 MEDIUM (VISUAL) TAN, POORLY GRADED SILTY SAND (SP-SM), WITH A TRACE OF GRAVEL SIZES, GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES FINE COARSE S 8 9.0-9.3 Depth COBBLES Sample No. Ω 8 8 8 2 8 S <del>\$</del> 8 2 2

PERCENT FINER BY WEIGHT





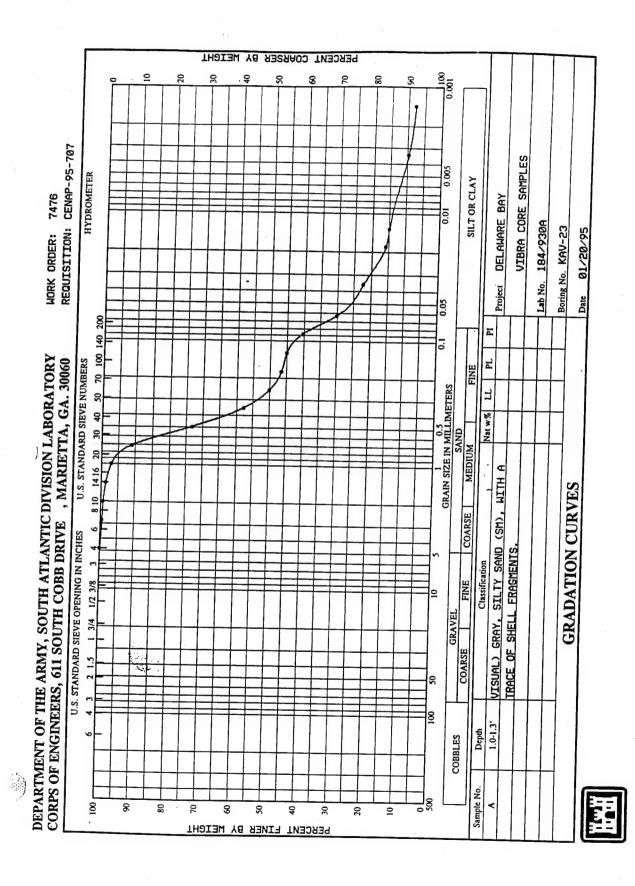


Project: DELAWARE	E BAY	Boring No. KAV-23		
Location: VIBRA COR	RE SAMPLES	Lab No. 184/930		
Boring Depth (ft): 12.	40	Work order: 7476		
Datum/Notes:			Requisition: CENAP-95-707	
Elev. Depth Leg- (feet) (feet) end	Ma	terial Description	al Description Comments	
(feet) (feet) end  1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10 — 11 —	GRAY, SILTY SAND SHELL FRAGMENTS.	ORGANIC SILT HIGH LL (NILTY SAND (SM).		Comments  (Density Units = pcf)  MA (A) 1.0-1.3'  MA D-1 3.1-3.6' WET DENSITY = 96.9, DRY DENSITY = 56.2, MC = 72.6 %  MA (B) 6.0-6.3'  SA D-2 7.4-7.9' WET DENSITY = 138.9, DRY DENSITY = 123.8, MC = 12.3 %, SA (C) 8.4-9.2'  SA (D) 11.0-11.2'  SA D-3 11.8-12.3' WET DENSITY = 137.3' DRY DENSITY = 116.8 MC = 13.3 %,

Date: 01/25/95

LABORATORY LOG AND SAMPLE DATUM

Sheet No. I of I



PERCENT COARSER BY WEIGHT 0.00 100.0 VIBRA CORE SAMPLES REQUISITION: CENAP-95-707 0.005 SILT OR CLAY HYDROMETER DELAWARE BAY 7476 0.0 Boring No. KAV-23 01/20/95 184/930 WORK ORDER: Lab No. Date Ы 5 7 001 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS
SAND 1 Nat w % 72.6 8 9 MEDIUM 3 10 14 16 20 (VISUAL) GRAY, INDRGANIC SILT HIGH LL GRADATION CURVES (MH), WITH A TRACE OF SAND SIZES. COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 96.9 PCF. DRY DENSITY = 56.2 PCF. Classification FINE SP. GRAVITY = 2.60 1/2 3/8 GRAVEL COARSE S 3.1-3.6 Depth COBBLES Sample No. 싞헎 4 9 20 <u>5</u> 8 8 8 8 PERCENT FINER BY WEIGHT



PERCENT COARSER BY WEIGHT 9.00 8.00 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 SILT OR CLAY HYDROMETER DELAWARE BAY 1847930B Boring No. KAV-23 01/20/95 Lab No. Project Date 0.05 50 70 100 140 200 6. DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 FINE GRAIN SIZE IN MILLIMETERS 1 Nat w % 30 40 SAND MEDIUM 14 16 20 (VISUAL) GRAY, INDRGANIC SILT HIGH LL GRADATION CURVES (MH), WITH A TRACE OF SAND SIZES, COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES FINE 1 3/4 1/2 3/8 COARSE S 8 6.0-6.3 Depth COBBLES Sample No. \_98 \_98 8 8 8 70 8 50 9 20 10 PERCENT FINER BY WEIGHT



8.00 8 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Boring No. KAV-23 184/930 01/20/95 Lab No. Date 0.05 교 30 40 50 70 100 140 <u>-</u> PL DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS ORAIN SIZE IN MILLIMETERS Nat w % 12.3 SAND MEDIUM 8 10 14 16 20 (VISUAL) GRAY, SILTY SAND (SM), WITH GRADATION CURVES COARSE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 138.9 PCF. DRY DENSITY = 123.8 PCF. A LITTLE GRAVEL SIZES. SP. GRAVITY = 2.66 FINE 1/2 3/8 GRAVEL COARSE S 8 7.4-7.9 Depth COBBLES Sample No. 57 8 80 S 6 30 20 2 8 20 8 PERCENT FINER BY WEIGHT

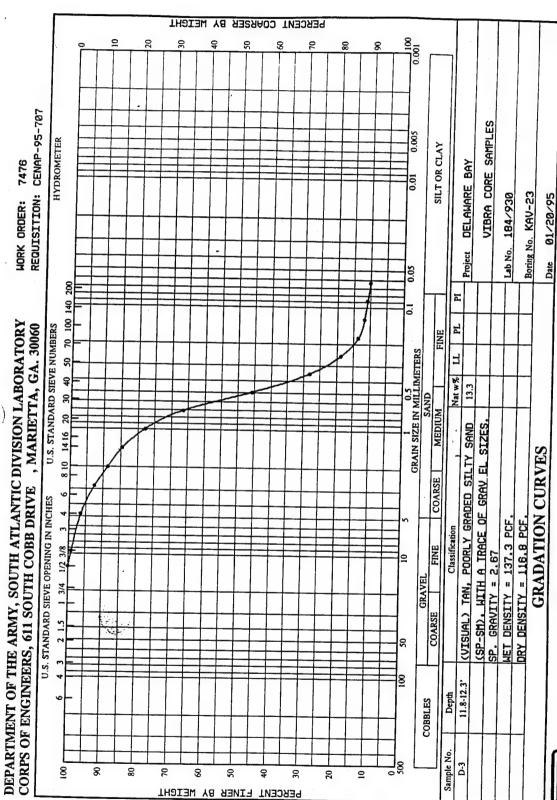


PERCENT COARSER BY WEIGHT 0.00 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Lab No. 1847930C Boring No. KAV-23 01/20/95 0.0 <del>5</del> <u>.</u> 50 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS
SAND
MEDIUM
FIN 크 8 10 14 16 20 GRADATION CURVES (VISUAL) GRAY, SANDY POORLY GRADED COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES Classification SILTY GRAVEL (GP-GM), FINE GRAVEL 8 8.4-9.2 Depth COBBLES Sample No. S 8 80 20 8 <del>\$</del> 20 20 10 PERCENT FINER BY WEIGHT



PERCENT COARSER BY WEIGHT 0.00 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 SILT OR CLAY HYDROMETER DELAWARE BAY 0.0 Lab No. 184/930D Boring No. KAU-23 01/20/95 Project 0.05 Ы ₹ 0. PL 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS
SAND 1 30 40 50 Nat w % MEDIUM 8 10 14 16 20 (VISUAL) TAN, SILTY SAND (SM), WITH GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES A TRACE OF GRAVEL SIZES. Classification FINE GRAVEL COARSE 11.0-11.2 Depth COBBLES Sample No. 8 2 8 8 2 8 S <del>2</del> 30 20 РЕКСЕИТ ГІИЕЯ ВҮ МЕІСНТ









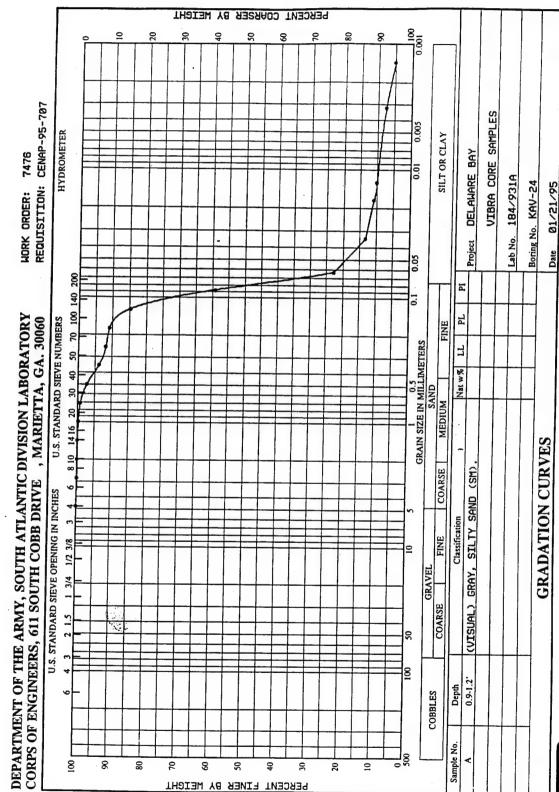
Project: DELAWARE BAY Boring No. KAV-24							
					Lab No. 184/931		
Boring	Depth (	ft): 18.	.50 Elevation:	Work order	Work order: 7476		
Datum	/Notes:	See gr	Requisition	: CENAP-95-707			
Elev. (feet)	Depth (feet)	Leg- end	Material Description		Comments		
	_				(Density Units = pcf)		
	1 -	ł			MA (A) 0.9 - 1.2'		
	2 -		GRAY, POORLY GRADED SILTY SAND (SP-SM).				
	-				SA D-1 2.5 - 3.0' WET DENSITY =		
	3 —				127.2, DRY DENSITY = 111.4, MC = 14.2		
	4 —	]	TAN, POORLY GRADED SAND (SP).		%. SA (B) 3.4 - 3.8'		
			GRAY, POORLY GRADED SILTY SAND (SP-SM).		(2)		
	5 -	1					
	6 —						
	7 -				- 0 0		
	,				MA D-2 7.4 - 7.9' WET DENSITY =		
	8		GRAY, INORGANIC SILT HIGH LL (MH), WITH A LITTLE SAND SIZES AND A TRACE OF MICA		98.9, 'DRY DENSITY = 62.5, MC = 58.2 9		
	9 —		THE STATE STATE STATE OF THE ST		•		
	-						
	10 -	1			MA (C) 10.4 - 10.7'		
	11 —	ļ 1					
	12 —				01 D 0 10 0 10 51 VITT D 10 10 10 10 10 10 10 10 10 10 10 10 10		
			TAN, POORLY GRADED SILTY SAND (SP-SM),	1	SA D-3 12.0 - 12.5' WET DENSITY 126.9,		
	13 —		WITH A TRACE OF GRAVEL SIZES AND POCKET OF GRAY, INORGANIC SILT HIGH LL (MH).	s	DRY DENSITY = 106.3, MC = 19.4 %.		
	14 —		G. Graif Engineers Stell Hall be Villy.		S. (D) 14.2 14.4		
	16 -	V	TAN, POORLY GRADED SAND (SP), WITH A		SA (D) 14.2 - 14.4'		
	15 —		TRACE OF GRAVEL SIZES.				
	16 —				MA D-4 15.9 - 16.4' WET DENSITY = 98.1.		
	17 —		GRAY, INORGANIC SILT HIGH LL (MH), WITH A TRACE OF SAND SIZES AND MICA.		DRY DENSITY = $76.2$ , MC = $28.7$ 9		
	-	}	TANNISH GRAY, POORLY GRADED SILTY SAND		SA (E) 17.5 - 17.8'		
	18 —		(SP-SM), WITH A TRACE OF GRAVEL SIZES.				
	19 —	}					
	-	1 .	· Company				

Date: 01/25/95

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LABORATORY LOG AND SAMPLE DATUM

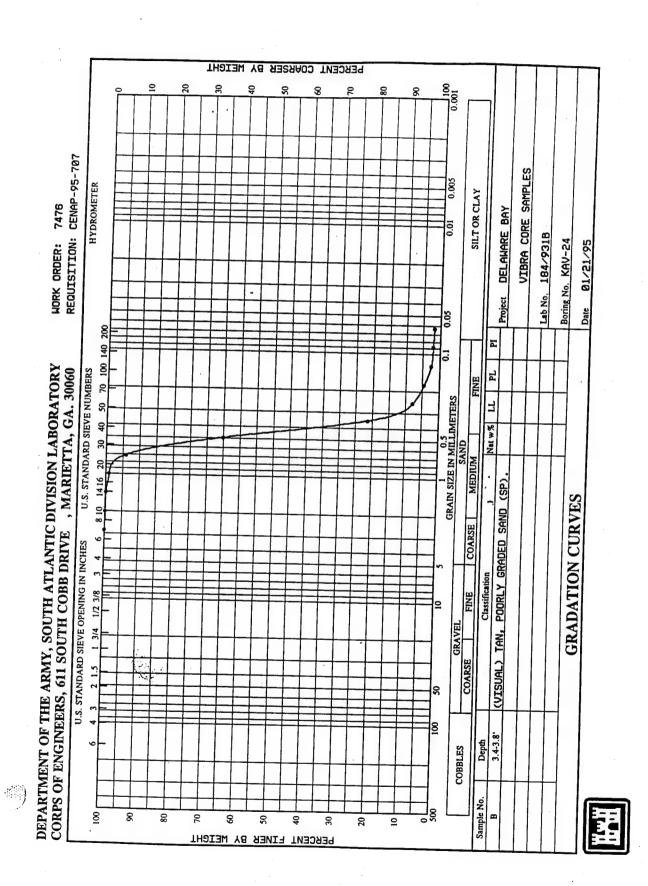
Sheet No. l of l





0.00 2 20 REGUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER 7476 DELAWARE BAY Boring No. KAV-24 01/20/95 Lab No. 184/931 WORK ORDER: Date 0.05 70 100 140 200 굽 ЪΓ DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 FINE U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS 7 Nat w% 8 10 14 16 20 30 40 14.2 SAND MEDIUM (VISUAL) GRAY, POORLY GRADED SILTY SAND GRADATION CURVES COARSE U.S. STANDARD SIEVE OPENING IN INCHES SP. GRAVITY = 2.68 WET DENSITY = 127.2 PCF. ORY DENSITY = 111.4 PCF FINE 1/2 3/8 GRAVEL COARSE (SP-SM). 100 2.5-3.0 Depth COBBLES Sample No. 4 8 2 8 20 PERCENT FINER BY WEIGHT

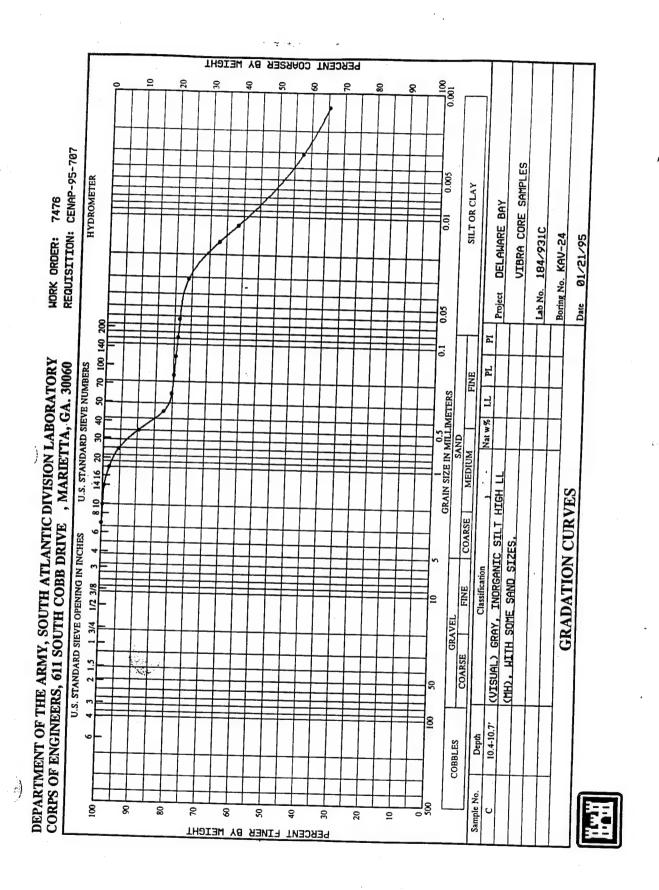




0.00 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES HYDROMETER SILT OR CLAY DELAWARE BAY Boring No. KAV-24 Lab No. 184/931 0.05 140 200 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 I 0.5 GRAIN SIZE IN MILLIMETERS Nat w % 58.2 SAND MEDIUM 8 10 14 16 20 (MH), WITH A TRACCE OF SAND SIZES AND MICA. SP. GRAVITY = 2.66 (VISUAL) TAN, INORGANIC SILT HIGH LL GRADATION CURVES SP. GRAVITY = 2.66 COARSE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 98.9 PCF. DRY DENSITY = 62.5 PCF. Classification FINE 1 3/4 1/2 3/8 2 GRAVEL COARSE S 8 7.4-7.9" Depth COBBLES Sample No. D-2 8 PERCENT FINER BY WEIGHT



01/25/95



PERCENT COARSER BY WEIGHT REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY MORK ORDER: 7476 Boring No. KAV-24 01/20/95 Lab No. 184/931 200 Ы 70 100 140 0.1 P. DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY FINE , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS 1 1 0.5 GRAIN SIZE IN MILLIMETERS S Nat w % 19.4 SAND 39 MEDIUM 8 10 14 16 20 (VISUAL) TAN, POORLY GRADED SILTY SAND (SP-SM), WITH A TRACE OF GRAVEL SIZES AND MICA. SP. GRAVITY = 2.66 GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES 1/2 3/8 3 4 DRY DENSITY = 106,3 PCF. WET DENSITY = 126.9 PCF. Classification FINE GRAVEL COARSE S 12.0-12.5 Depth COBBLES Sample No. 김홍 D-3 20 10 8 80 2 8 20 6 2 PERCENT FINER BY WEIGHT



Sander . PERCENT COARSER BY WEIGHT 0.00 8 TO WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Lab No. 184/931D Boring No. KAV-24 81/21/95 Ы 70 100 140 Td DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS FINE GRAIN SIZE IN MILLIMETERS
SAND
MEDIUM FIN 1 Nat w% <del>\$</del> 3 8 10 14 16 20 (SP). **GRADATION CURVES** (VISUAL) TAN, POORLY GRADED SAND COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE 1/2 3/8 GRAVEL COARSE S 001 14.2-14.4" Depth COBBLES Sample No. ۵ 8 20 2 8 80 5 8 40 9 20 PERCENT FINER BY WEIGHT



0.00 0.00 0.00 REGUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Boring No. KAV-24 01/25/95 Lab No. 184/931 0.05 0.1 ЪГ 70 100 U.S. STANDARD SIEVE NUMBERS FINE , MARIETTA, GA. 30060 GRAIN SIZE IN MILLIMETERS
SAND
MEDIUM
FINA 1 Nat w % 28.7 (MH). WITH A TRACE OF SAND SIZES & MICA. (VISUAL) TAN, INDRGANIC SILT HIGH LL GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 98.1 PCF. DRY DENSITY = 76.2 PCF Classification FINE SP. GRAVITY = 2.68 1/2 3/8 GRAVEL COARSE ಜ 15.7-16.2 Depth COBBLES Sample No. 4 . 100 8 8 20 20 PERCENT FINER BY WEIGHT

MORK ORDER: 7476

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY

PERCENT COARSER BY WEIGHT REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES HYDROMETER SILT OR CLAY 7476 DELAWARE BAY Lab No. 184/931E Boring No. KAV-24 01/21/95 WORK ORDER: 140 200 90 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY Z U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 FINE GRAIN SIZE IN MILLIMETERS = Nat w % 6 MEDIUM 8 10 14 16 (VISUAL) TANNISH GRAY, POORLY GRADED SILIY SAND (SP-SM). WITH A TRACE OF GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE 1 3/4 1/2 3/8 GRAVEL GRAVEL SIZES. COARSE S 8 17.5-17.8 Depth COBBLES Sample No. 8 8 8 2 8 50 20 10 PERCENT FINER BY WEIGHT





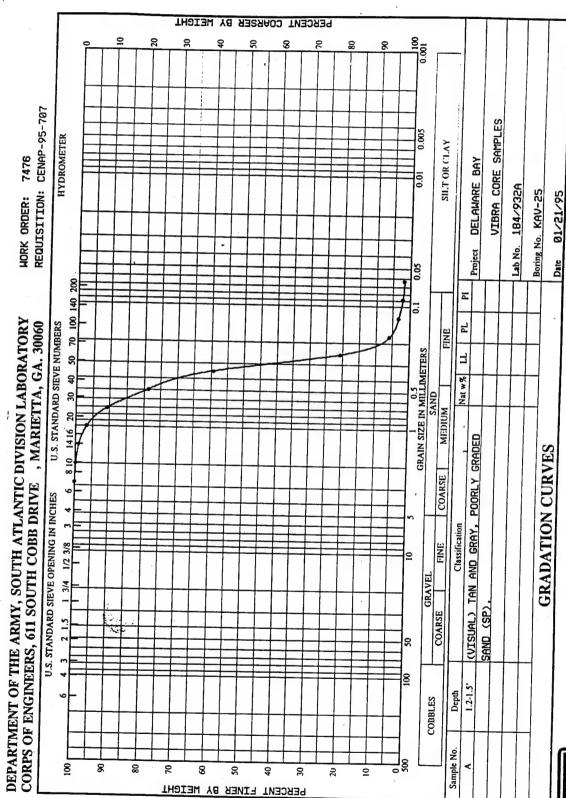
Project: DELAWARE BAY	•	Boring No.	KAV-25
Location: VIBRA CORE SAMPLES		Lab No.	184/932
Boring Depth (ft): 17.00	Elevation:	Work order:	7476
Datum/Notes: See grain size data on enclos	Requisition:	CENAP-95-707	
Fley Denth Leg-			

Γ	Elev. (feet)	Depth (feet)	Leg- end	Material Description	Comments
丨		_			(Density Units = pcf)
١		1 -		TAN AND GRAY, POORLY GRADED SAND (SP), WITH A TRACE OF GRAVEL SIZES AND GRAVEL SIZE SHELL	SA (A) 1.2 - 1.5'
		2			SA D-1 2.8 - 3.3' WET DENSITY =
		4 —			137.9, DRY DENSITY = 121.1, MC = 13.9 %.
		5 — - 6 —			MA (B) 5.6 - 5.8'
		7 —			MA D-2 6.9 - 7.4' WET DENSITY = 101.2, DRY DENSITY = 62.2, MC = 62.5 %.
	-	9 —		GRAY, INORGANIC SILT HIGH LL (MH), WITH OCCASIONAL LENSES OF POORLY GRADED SILTY SAND (SP-SM) AND A TRACE OF MICA.	MA (C) 8.9 - 9.2
	•	10 -		SAND COLUMN AND A TRACE OF TECH.	
		12 -	٠,.		MA (D) 11.3 - 11.5
		13 —			MA D-3 13.4 - 13.9' WET DENSITY = 105.2, DRY DENSITY = 66.3, MC = 58.7 %
		15			MA (E) 15.1 - 15.4'
		16 — 17 — -			MA D-4 16.5 - 17.0' WET DENSITY = 92.6, DRY DENSITY = 55.7, MC = 66.2 9

Date: 01/21/95

LABORATORY LOG AND SAMPLE DATUM

Sheet No. 1 of 1

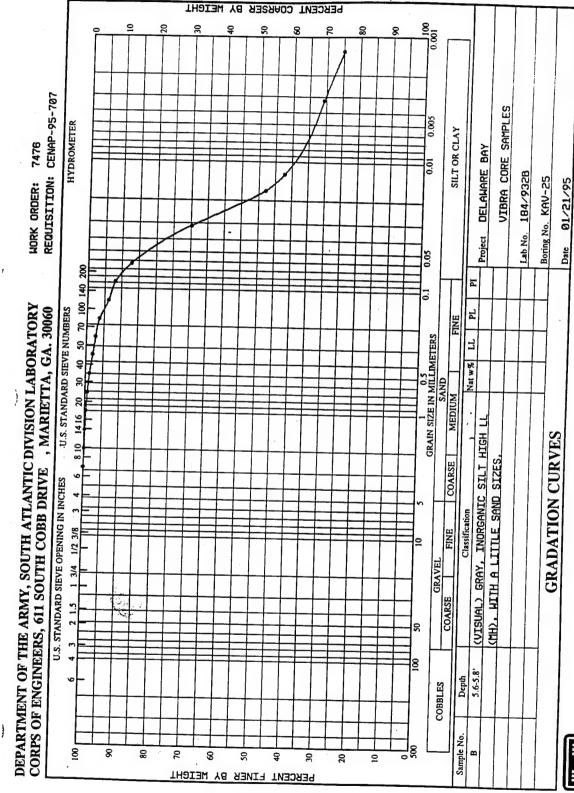




9.00 8.00 8.00 MORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 SILT OR CLAY HYDROMETER DELAWARE BAY Boring No. KAV-25 01/21/95 Lab No. 184/932 Date 0.05 Z <u>-</u> ₹ 9 긺 50 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS 1 I 0.5 GRAIN SIZE IN MILLIMETERS Nat w % 13.9 30 40 SAND MEDIUM 8 10 14 16 20 SP. GR. = 2.66 (VISUAL) GRAY, SILTY SAND (SM), WITH SOME GRAVEL SIZES, A TRACE OF SHELL FRAGMENTS AND MICA, SP. GR. = 2 GRADATION CURVES COARSE U.S. STANDARD SIEVE OPENING IN INCHES DRY DENSITY = 121.2 PCF. WET DENSITY = 137.9 PCF. Classification FINE 1 3/4 1/2 3/8 GRAVEL COARSE 8 2.8-3.3 Depth COBBLES Sample No. 宀ఠ 4 20 8 8 80 20 જ ŝ 6 3 PERCENT FINER BY WEIGHT

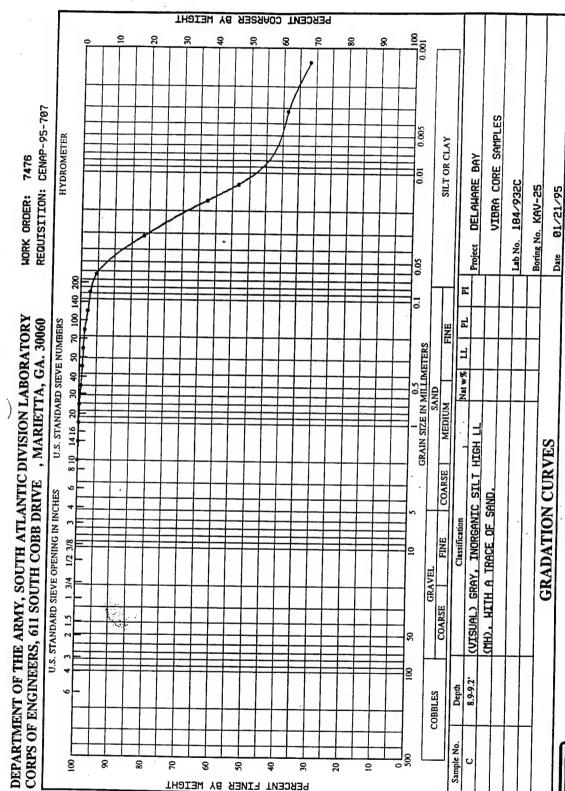
PERCENT COARSER BY WEIGHT





PERCENT COARSER BY WEIGHT 0.00 2 MORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Boring No. KAV-25 01/21/95 184/932 Lab No. Date 0.1 ₹ 된 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 GRAIN SIZE IN MILLIMETERS Nat w % 62.5 SAND 30 40 8 10 14 16 20 (VISUAL) GRAY, INORGANIC SILT HIGH LL GRADATION CURVES (MH), WITH A LITTLE SAND SIZES, CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 101.2 PCF. DRY DENSITY = 62.2 PCF. Classification FINE SP. GRAVITY = 2.68 1 3/4 1/2 3/8 GRAVEL COARSE 90 6.9-7.4" Depth COBBLES Sample No D-2 20 2 ક 8 8 PERCENT FINER BY WEIGHT







0.00 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 SILT OR CLAY HYDROMETER DELAWARE BAY Lab No. 184/932D Boring No. KAV-25 01/21/95 140 200 001 02 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY U.S. STANDARD SIEVE NUMBERS CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 FINE ORAIN SIZE IN MILLIMETERS Ľ Nat w & SAND MEDIUM (VISUAL) GRAY, INDRGANIC SILT HIGH LL GRADATION CURVES (MH). WITH A TRACE OF SAND SIZES. U.S. STANDARD SIEVE OPENING IN INCHES FINE 1/2 3/8 GRAVEL ೪ 8 11.3-11.5 Depth COBBLES Sample No. 宀 8 8 6 2 8 70 8 S 2 20 PERCENT FINER BY WEIGHT

PERCENT COARSER BY WEIGHT

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PERCENT COARSER BY WEIGHT WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 HYDROMETER SILT OR CLAY DELAWARE BAY Boring No. KAV-25 01/21/95 Lab No. 184/932 0.05 (교 70 100 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS FINE GRAIN SIZE IN MILLIMETERS 7 30 40 50 Nat w % 58.7 SAND MEDIUM 8 10 14 16 20 (VISUAL) GRAY, INORGANIC SILT HIGH LL (MH). WITH A TRACE OF SAND AND MICA. **GRADATION CURVES** COARSE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 105.2 PCF. DRY DENSITY = 66.3 PCF. Classification FINE SP. GRAVITY = 2.65 GRAVEL COARSE S 8 13.4-13.9 Depth COBBLES Sample No. \_08 \_08 5 8 8 2 8 20 \$ 30 20 2 PERCENT FINER BY WEIGHT



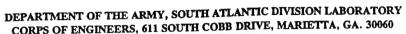
PERCENT COARSER BY WEIGHT 8 0.00 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY WORK ORDER: 7476 1847932E Boring No. KAV-25 01/21/95 Lab No. Date 0.05 50 70 100 140 200 <del>.</del> PL DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS 1 110 1416 20 30 40 5 Nat w % SAND (VISUAL) GRAY, INORGANIC SILT HIGH LL GRADATION CURVES (MH), WITH A TRACE OF SAND SIZES, COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE 1 3/4 1/2 3/8 GRAVEL COARSE ೪ 15.1-15.4 Depth COBBLES Sample No. 긲& ш 001 20 2 8 8 70 8 50 40 30 PERCENT FINER BY WEIGHT



PERCENT COARSER BY WEIGHT 8 0.00 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.005 HYDROMETER SILT OR CLAY 7476 DELAWARE BAY Boring No. KAV-25 Lab No. 184/932 01/21/95 WORK ORDER: 0.05 50 70 100 140 200 굽 <u>-</u> DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY 7 , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS FINE GRAIN SIZE IN MILLIMETERS 금 Nat w % \$ 66.2 MEDIUM 8 10 14 16 (VISUAL) GRAY, INORGANIC SILT HIGH LL (MH). WITH A TRACE OF SAND AND MICA, GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES DRY DENSITY = 55.7 PCF. WET DENSITY = 92.6 PCF. Classification FINE SP. GRAVITY = 2.65 GRAVEL COARSE S 8 16.5-17.0 Depth COBBLES Sample No. 4 8 8 80 20 8 50 30 9 \$ 20 PERCENT FINER BY WEIGHT

mark kdg in pr







		COR	PS OF ENGINEERS, 611 SOUTH COBB DRIVE,	MARIETT	A, GA. 30060	
Project: DELAWARE BAY Bor					Boring No. KAV-26	
Location: VIBRA CORE SAMPLES Lat					ab No. 184/933	
Boring Depth (ft): 15.30 Elevation:				Work order: 7476		
	/Notes:		ain size data on enclosed gradation curves.	Requisiti	on: CENAP-95-707	
Elev.	Depth (feet)	Leg- end	Material Description		Comments	
(ICCI)	-	-	LT. BROWN, POORLY GRADED SILTY SAND (SP-SM).		(Density Units = pcf)	
	1 -		GRAY, SILTY SAND (SM), WITH A TRACE OF	=	MA (A) 1.1 - 1.3°	
	2 -					
	3 -		GRAY, GRAVELLY POORLY GRADED SAND (SP	·	SA D-1 3.0 - 3.5' WET DENSITY = 137.8, DRY DENSITY = 131.0, MC = 5.2	
	4 -					
	5 -	-				
	6 -	_	GRAY, POORLY GRADED SILTY SAND (SP-SM	).	SA (B) 6.1 - 6.3'	
•	8 -				SA D-2 7.2 - 7.7' WET DENSITY = 137.8, DRY DENSITY = 121.8, MC = 13.2	
	9 -	-	GRAY, POORLY GRADED SILTY SAND (SP-SM WITH SOME GRAVEL SIZES.	D,	%. SA (C) 9.0 - 9.5'	
	10 -	-			•	
	11 -		GRAY, POORLY GRADED SAND (SP), WITH A		SA (D) 11.5 - 11.8'	
	12 -	- 1	4		SA D-3 12.5 - 13.0' WET DENSIT	
	13 -	-	GRAY, POORLY GRADED SAND (SP), WITH (TRACE OF GRAVEL SIZES.	A	125.4, DRY DENSITY = 117.2, MC = 7.0 SA (E) 13.6 - 14.1	
	15					

Date: 01/21/95

LABORATORY LOG AND SAMPLE DATUM

Sheet No.  ${\it 1}$  of  ${\it 1}$ 

PERCENT COARSER BY WEIGHT 8 0 0 0 0 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY 7476 Lab No. 184/933A Boring No. KAV-26 01/25/95 WORK ORDER: Project Date 0.05 교 40 50 70 100 140 0.1 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS FINE GRAIN SIZE IN MILLIMETERS Ľ Nat w % SAND MEDIUM 8 10 14 16 20 (VISUAL) GRAY, SILTY SAND (SM), WITH GRADATION CURVES COARSE U.S. STANDARD SIEVE OPENING IN INCHES Classification A LITILE GRAVEL SIZES. FINE 1 3/4 1/2 3/8 GRAVEL COARSE 8 1.1-1.3 Depth COBBLES Sample No. 8 80 20 PERCENT FINER BY WEIGHT



PERCENT COARSER BY WEIGHT 0.001 2 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES 0.002 HYDROMETER SILT OR CLAY DELAWARE BAY Boring No. KAV-26 01/21/95 Lab No. 184/933 Date 140 200 Ы 50 70 100 Ы DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 FINE U.S. STANDARD SIEVE NUMBERS I 0.5 GRAIN SIZE IN MILLIMETERS 1 Nat w % \$ 5.2 SAND MEDIUM 8 10 14 16 20 (VISUAL) GRAY, GRAVELLY POORLY GRADED GRADATION CURVES COARSE U.S. STANDARD SIEVE OPENING IN INCHES SP. GRAVITY = 2.65 WET DENSITY = 137.8 PCF. DRY DENSITY = 131.0 PCF. Classification FINE 3/4 1/2 3/8 GRAVEL SAND (SP) COARSE 20 3.0-3.5 Depth COBBLES Sample No. 100 1 ā 2 8 8 70 8 20 \$ 30 20 PERCENT FINER BY WEIGHT



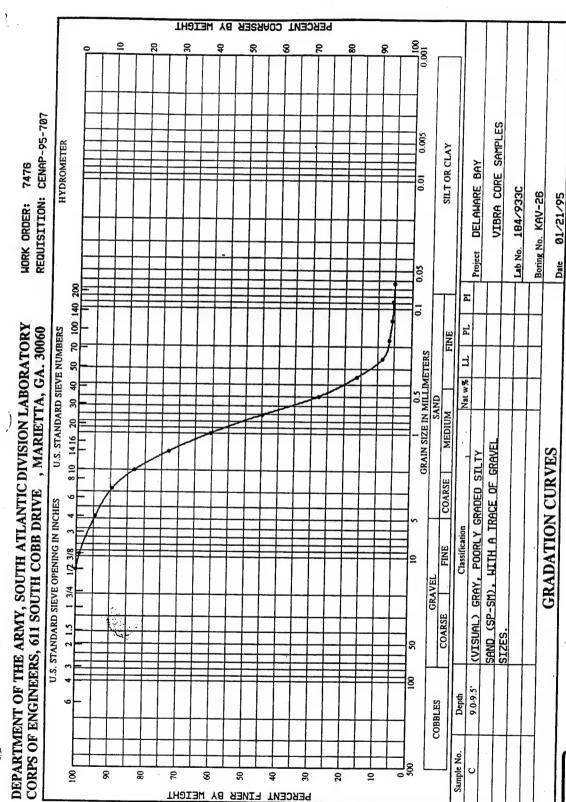
PERCENT COARSER BY WEIGHT 0.0 0.0 0.0 8 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES HYDROMETER SILT OR CLAY Project DELAWARE BAY Lab No. 184/933B Boring No. KAV-26 01/21/95 Date 70 100 PL DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS 11 Nat w St SAND MEDIUM 8 10 14 16 20 GRADATION CURVES COARSE (VISUAL) GRAY, SILTY SAND (SM) CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE 1/2 3/8 GRAVEL 1 3/4 COARSE 6.1-6.3 Depth COBBLES Sample No. 8 8 20 2 8

PERCENT FINER BY WEIGHT



PERCENT COARSER BY WEIGHT 8 0.00 WORK ORDER: 7478 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Boring No. KAV-28 01/25/95 184/933 Lab No. 50 70 100 140 200 0.1 DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS Nat w & 810 1416 20 30 40 13.2 SAND (VISUAL) GRAY, SILTY SAND (SM), WITH GRADATION CURVES COARSE CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES JET DENSITY = 137.8 PCF. DRY DENSITY = 121.8 PCF. FINE SP. GRAVITY = 2.66 SOME GRAVEL SIZES. 1/2 3/8 GRAVEL COARSE 7.2-7.7 Depth COBBLES Sample No. D-2 <u>8</u> 2 20 8 8 PERCENT FINER BY WEIGHT







PERCENT COARSER BY WEIGHT 0.0 0.00 8 2 VIBRA CORE SAMPLES REQUISITION: CENAP-95-707 SILT OR CLAY HYDROMETER Project DELAWARE BAY WORK ORDER: 7476 Lab No. 184/933D Boring No. KAV-26 01/21/95 ₹ ΙL 70 100 FINE DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY U.S. STANDARD SIEVE NUMBERS CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 1 0.5 GRAIN SIZE IN MILLIMETERS SAND ı Nat w % 3 MEDIUM (VISUAL) GRAY, POORLY GRADED SAND (SP) 8 10 14 16 GRADATION CURVES COARSE U.S. STANDARD SIEVE OPENING IN INCHES FINE 1 3/4 1/2 3/8 GRAVEL COARSE 20 8 11.5-11.8" Depth COBBLES Sample No. 20 8 20 8 S 8 8 PERCENT FINER BY WEIGHT



PERCENT COARSER BY WEIGHT 9.00 8.00 WORK ORDER: 7476 REQUISITION: CENAP-95-707 VIBRA CORE SAMPLES SILT OR CLAY HYDROMETER DELAWARE BAY Boring No. KAV-26 01/21/95 Lab No. 1847933 H 70 100 140 F DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY FINE U.S. STANDARD SIEVE NUMBERS , MARIETTA, GA. 30060 GRAIN SIZE IN MILLIMETERS 7 S Nat w% 7.0 MEDIUM 8 10 14 16 20 (SP) GRADATION CURVES (VISUAL) GRAY, POORLY GRADED SAND COARSE WITH A TRACE OF GRAVEL SIZES CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE U.S. STANDARD SIEVE OPENING IN INCHES WET DENSITY = 125.4 PCF. DRY DENSITY = 117.2 PCF. Classification FINE SP. GRAVITY = 2.63 GRAVEL COARSE S 12.5-13.0" Depth COBBLES Sample No. D-3 2 8 80 20 8 20 20 PERCENT FINER BY WEIGHT



2 0.00 WORK ORDER: 7476 REQUISITION: CENAP-95-707 SAMPLES 0.00 SILT OR CLAY HYDROMETER DELAWARE BAY VIBRA CORE 184/933E Boring No. KAV-26 01/21/95 Lab No. 200 70 100 140 F DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060 U.S. STANDARD SIEVE NUMBERS GRAIN SIZE IN MILLIMETERS
SAND
SAND
FINEDRIM
FIN T 20 Nat w% 9 30 8 10 14 16 20 SAND (SP-SM). WITH A TRACE OF GRAVEL GRADATION CURVES (VISUAL) GRAY, POORLY GRADED SILTY COARSE U.S. STANDARD SIEVE OPENING IN INCHES Classification FINE GRAVEL COARSE SIZES. S 8 13.6-14.1 Depth COBBLES Sample No. 8 2 8 80 70 8 S 4 30 20 PERCENT FINER BY WEIGHT

PERCENT COARSER BY WEIGHT



## REPORT DOCUMENTATION PAGE

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5. FUNDING NUMBERS

**AUTHOR(S)** 

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## 13. ABSTRACT (Maximum 200 words)

Erosion is occurring along the shoreline of Delaware Bay, comprising the east coast within the state of New Jersey and the west coast within the state of Delaware. This erosion has resulted in a need to investigate the shallow offshore areas of the bay adjacent to both the Delaware and New Jersey coasts for use as borrow areas for beachfill material. The area is relatively unexplored from a geotechnical standpoint and this investigation will provide acoustical subbottom profiling, vibracore locations, and interpretation of the sediment substrate of the study area. Seismic and sedimentological data from vibracore samples were interpreted, and this report characterizes the sediment of the Broadkill Beach portion on the west side of the bay of the Delaware Beach study. This report also suggests suitable borrow areas for beachfill use.

14. SUBJECT TERMS

Beachfill borrow area assessment

Broadkill Beach

Delaware Bay

15. NUMBER OF PAGES

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**OF ABSTRACT**